GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. A-3261 DATE 6/25/82

Project Director: ~~James L. Burson~~ W. EWING School/Lab EDL

Sponsor: McLain & Merritt, P.C.; Atlanta, GA

Type Agreement: Research Project Agreement dated 5/21/82

Award Period: From 5/15/82 To ~~9/30/82~~ 11/30/82 (Performance) _____ (Reports)

Sponsor Amount: $4,700 Contracted through:

Cost Sharing: N/A GTRI/~~GIT~~

Title: Industrial Hygiene Sampling Survey

ADMINISTRATIVE DATA

OCA Contact Leamon R. Scott

1) Sponsor Technical Contact:

Robert B. Hill
McLain & Merritt, PC.
1250 Tower Place
Atlanta 30326

2) Sponsor Admin/Contractual Matters:

Same

Defense Priority Rating: n/a

Security Classification: n/a

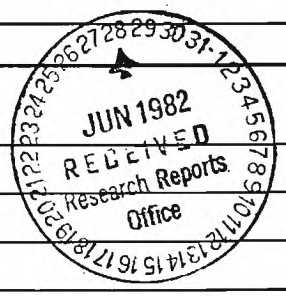
RESTRICTIONS

See Attached n/a Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with n/a

COMMENTS:



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FORM OCA 4:781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 2/17/83

Project Title: Industrial Hygiene Sampling Survey

Project No: A-3261

Project Director: James L. Burson

Sponsor: McLain & Merritt

Effective Termination Date: 11/30/82 (performance)

Clearance of Accounting Charges: 1/31/83 (final report)

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice and ~~Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: EDL/SHD (School/~~Laboratory~~)

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A-3261

INDUSTRIAL HYGIENE SAMPLING SURVEY
at
ZEP MANUFACTURING COMPANY
1310 Seaboard Industrial Boulevard, N.W.
Atlanta, Georgia
for
MCLAIN AND MERRITT, P.C.
1250 Tower Place
Atlanta, Georgia 30026-3901

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Occupational Safety and Health Branch
Atlanta, Georgia
July 30, 1982

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Project No. A-3261
July 30, 1982

1.0 INTRODUCTION

At the request of Mr. Robert Hill of McLain and Merritt, P.C., an industrial hygiene sampling survey was conducted at the powders department of ZEP Manufacturing Company's 1310 Seaboard Industrial Boulevard, N.W., Atlanta, Georgia facility. The survey was conducted by Mr. William M. Ewing of the Georgia Institute of Technology, Engineering Experiment Station, on May 20, 1982.

The purpose of the survey was to determine employee exposure to selected chemical compounds in use on the day of the survey. Additionally, measurements were taken to estimate employee exposure to noise and carbon monoxide. Further, work practices, including the use of personal protective equipment and housekeeping practices were reviewed. Ventilation measurements were also taken to evaluate existing local exhaust systems in the powders department. The following report summarizes the results of this survey including conclusions and recommendations.

2.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations are based on the results of air sampling, on-site measurements, observations, and interviews with the employees and management of ZEP Manufacturing Company.

2.1 CONCLUSIONS

2.1.1 Employees working in the lower and upper powders department were not exposed to airborne total dust, total respirable dust, sodium hydroxide, or pentachlorophenol in excess of current OSHA permissable exposure limits (PELs) for each of these compounds determined as 8-hour, time-weighted averages (TWAs).

2.1.2 Employees working in the upper powders department were exposed to lower concentrations of the airborne contaminants sampled than employees working in the lower powders area.

2.1.3 The two lift-truck operators were not exposed to carbon monoxide in excess of the OSHA PEL for this gas determined as an 8-hour, TWA.

2.1.4 Employees monitored for the contaminants referenced in 2.1.1 and 2.1.3 were not exposed in excess of the current American Conference of Governmental Industrial Hygiene (ACGIH) Threshold Limit Values (TLVs) or the National Institute for Occupational Safety and Health (NIOSH) recommended PELs for these compounds.

2.1.5 Airborne dust exposures were generally higher during this survey than during the survey conducted on April 2, 1980 performed by the same industrial hygienist. A review of the production data on the two days of sampling, ventilation measurements, and observations indicates this is probably due to a reduction in the efficiency of local exhaust ventilation in the lower powders area.

2.1.6 The conscientious use of personal protective equipment by the employees including gloves, clothing, aprons, and boots reduces the chance of skin contaminantion through skin contact when handling compounds such as caustic soda and pentachlorophenol.

2.1.7 The wearing of eye protection (safety glasses with side shields, goggles, splash shields) was inconsistent increasing the possibility for eye injury.

2.1.8 Housekeeping and personal hygiene were adequate on the day of sampling.

2.1.9 Noise dosimetry and instantaneous A-weighted sound level measurements conducted throughout the powders department indicated employee noise exposure below the current OSHA PEL of 90 dBA, 8-hour exposure. Further, the results did not indicate any employees in the powders department exposed over the 85 dBA "action level" (8-hour exposure) currently in use by OSHA.

2.2 RECOMMENDATIONS

2.2.1 All hoods and ductwork of the local exhaust ventilation system should be cleaned on a regular schedule to remove built-up deposits of dust.

2.2.2 The three hoods located directly above the work stations at the lower powders dispensing hoppers should be disconnected from the remainder of the system. This will increase ventilation at the dispensing stations (Nos. 1-6) and eliminate the competition between the local exhaust at the drum filling areas and the overhead hoods.

2.2.3 All dampers not operable should be repaired and cleaned. Employees should be trained to close the dampers on exhaust ports (hoods) not in use. This will increase local exhaust for the hoods in use.

2.2.4 Employees choosing to use the disposable respirators supplied by ZEP Manufacturing should be enrolled in a respiratory protection program as required by OSHA (29 CFR 1910.134).

2.2.5 The use of eye protection by employees in the powders department should be enforced to prevent eye injury.

2.2.6 All compounds used should be labeled as to any potentially hazardous ingredients. This label should include statements regarding precautions for handling the compound.

2.2.7 Employees handling any hazardous compounds should be trained in proper precautions to protect themselves.

2.2.8 The drum storage area in the upper powders area should be diked to contain any spills or leaks. The containers should be labeled and any incompatable compounds stored separately.

2.2.9 Lift truck operators should be instructed to turn off their trucks when not in use to prevent the build-up of carbon monoxide in the workplace.

2.2.10 Carbon monoxide measurements should be taken during the winter months. The reduced general ventilation due to exterior doors remaining closed during the workday may permit carbon monoxide build-up.

2.2.11 Consideration should be given to installing vertical sliding doors on the upper powder hood openings. This should eliminate the need to turn off the man-cooling fans every time materials are added to the hopper. Further, it would greatly increase the capture velocity at one side of the hood when the other side is closed.

3.0 DESCRIPTION OF OPERATIONS

ZEP Manufacturing Company is engaged in the production of commercial, institutional, and industrial chemicals for use in sanitation and maintenance. Products include liquids, powders, and a wide variety of aersols and sprays which are used as waxes, polishes, water treatment chemicals, deodorants, cleaners, disinfectants, degreasers, weed killers, insecticides, and for other purposes. The Atlanta facility manufacturers approximately 90% of the product range offered by ZEP Manufacturing. The facility consists of five production areas, warehouse facilities, quality control laboratory, and the general offices. The scope of this industrial hygiene survey was limited to the upper and lower powders department.

3.1 UPPER AND LOWER POWDERS

The powder house (Figures 3.0-1 and 3.0-2) serves as the location for mixing and packaging of powdered products. This facility is divided into an upper mixing and storage area and a lower packaging and storage area. Six mixing stations are located in the upper mixing area manned by approximately four employees. Many of the raw materials used in the process are stored in this same area. The ingredients are added to a hopper by breaking the bags of raw materials on a toothed grating. This bag-breaking operation is conducted under a semi-closed, exhaust hood. The various ingredients are collected in the hopper and held until the mixer is empty. Once emplty the new batch flows into the mixer through a short chute. After a short mixing period to assure a uniform mixing, the powder is dispensed into drums for storage. The drum filling occurs at six stations on the lower level of the facility. The filling operation employs

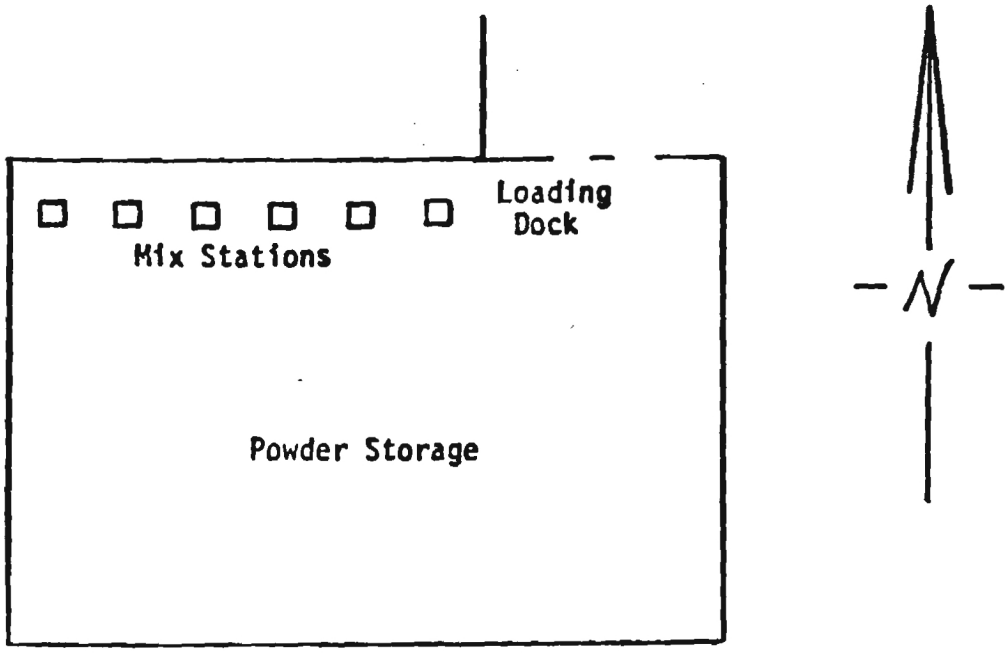


Figure 3.0-1
UPPER POWDER ROOM Scale: 1"=40'- 0"

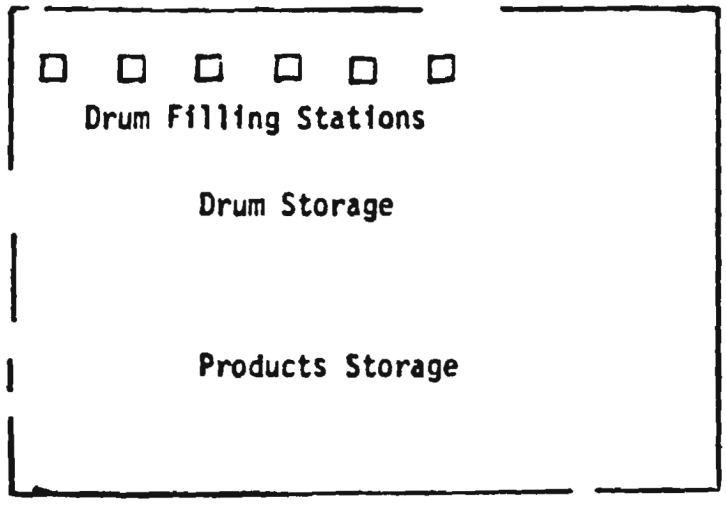


Figure 3.0-2
LOWER POWDER ROOM Scale: 1"=40'- 0"

ZEP MANUFACTURING COMPANY
Atlanta, Georgia

six persons working in teams of two. Each team operates two mixing tanks. A diagram of a single mixing chamber, including chute and hopper, is included for clarity (Figure 3.1-3).

4.0 DISCUSSION OF FINDINGS

4.1 RESULTS OF AIR SAMPLING

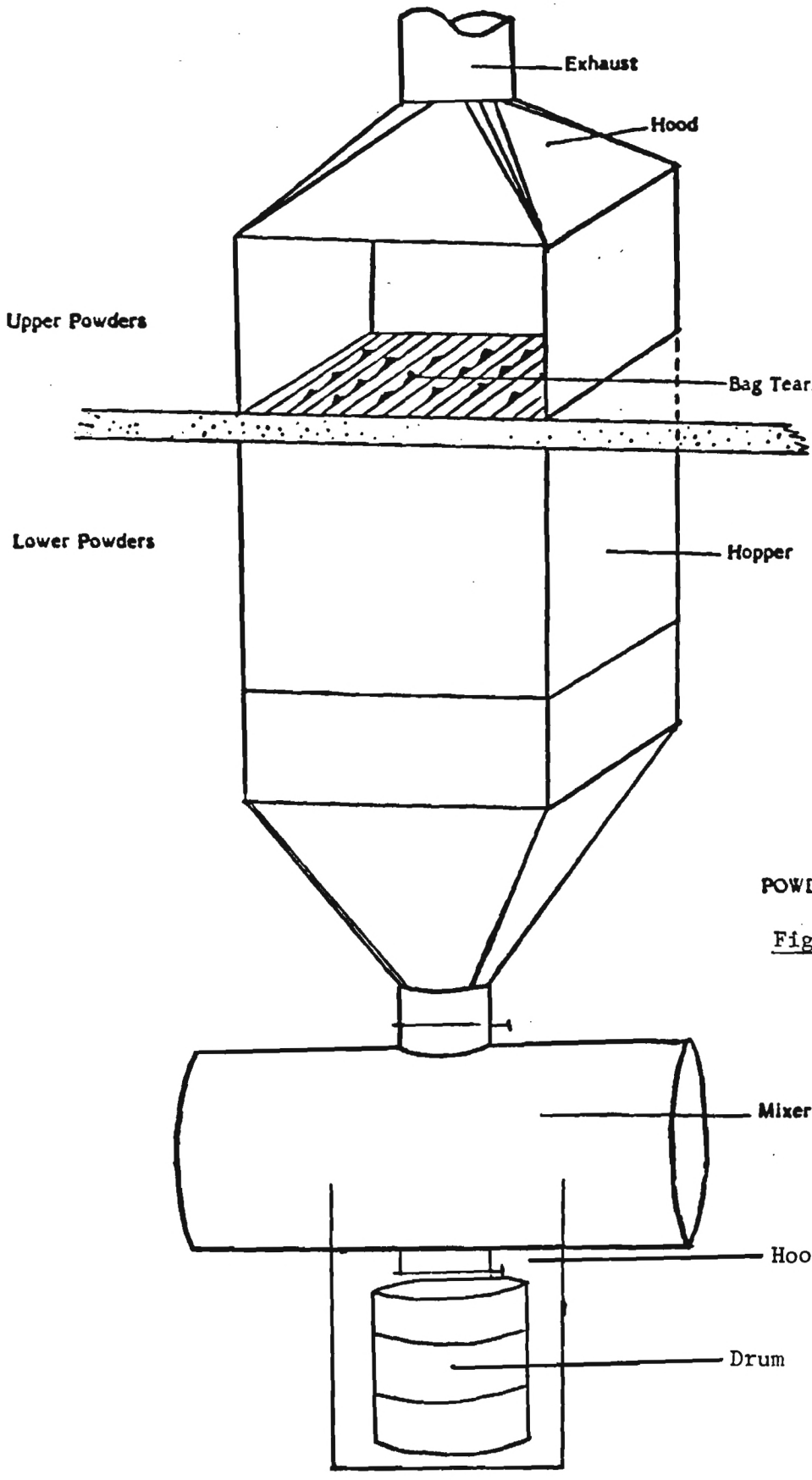
A total of 14 personal air samples were collected in the breathing zones of employees working in the powders department. The employees participating in the study included those working in upper powders, lower powders, small packaging department, the supervisor, the floor manager, and two lift truck operators. A walk-through survey indicated the potential for highest exposures to dusts would be in the lower powders barrel filling stations.

Of the 14 samples, eight were collected and analyzed for total dust and sodium hydroxide. Three samples were collected and analyzed for pentachlorophenol (PCP). Two samples were collected to determine employee exposure to carbon monoxide and one sample was collected and analyzed for total respirable dust (TRD).

The results of 8 personal samples analyzed gravimetrically for total dust indicated a range from 0.50 mg/m^3 to 8.94 mg/m^3, determined as 8-hour TWAs. The lowest concentration was collected in the breathing zone of the powders house supervisor. The highest concentration of total dust was detected in a personal sample taken for the mixer 5 and 6 operator in the lower powders department.

It was noted that all samples indicated total dust concentrations below the current OSHA PEL of 15 mg/m^3, determined as an 8-hour TWA. Further, all samples indicated total dust concentrations below the current 8-hour TWA ACGIH TLV of 10 mg/m^3. The results of individual samples have been compiled in Table A-1 of Appendix A.

One sample was collected in the breathing zone of an employee working at lower powders mixers 5 and 6 to determine exposure to total respirable dust. The sampling media was preceded by a 10 mm nylon cyclone separator. The employee selected for this test worked in the area exhibiting the highest concentration of total dust (8.94 mg/m^3, 8-hour TWA for his co-worker). The analysis of this respirable dust sample indicated a concentration of 3.85 mg/m^3, determined as an 8-hour, TWA. It was noted upon post-survey calibration of the sampling pump that the flowrate had increased to 1.94 liters per minute. This information indicates that the results reported are probably higher than the actual concentration of respirable dust in the worker's breathing zone. (The cyclone separator operates properly at 1.7 liters per minute. Flowrates higher than 1.7 liters per minute will result in higher than actual concentrations, while flowrates lower than 1.7 liters per minute will result in lower than actual concentrations). Even with the results slightly higher than actual, the indicated TRD concentration was below both the OSHA PEL and the ACGIH TLV of 5 mg/m^3, determined as an 8-hour TWA.



POWDER MIX STATION

Figure 3.0-3

Each of the total dust samples were also analyzed for sodium hydroxide using the NIOSH analytical method S381. These results have been compiled in Appendix A, Table A-1. Sodium hydroxide was not detected in six of the eight samples analyzed, according, the corresponding limit of detection (LOD) has been reported for each sample. Sodium hydroxide was detected in two personal samples and yielded 8-hour, TWA concentrations of 0.066 and 0.14 mg/m^3, respectively. The current OSHA PEL for sodium hydroxide is 2.0 mg/m^3, determined as an 8-hour, TWA. The recommended NIOSH PEL and ACGIH TLV is 2.0 mg/m^3 determined as a ceiling concentration. These values were not exceeded.

Three samples were collected and analyzed for pentachlorophenol by high performance liquid chromatography (HPCL). These samples were collected in the breathing zone of employees handling Dowicide GST known to contain sodium pentachlorophenate. Pentachlorophenol was not detected in any of the samples; accordingly, a limit of detection has been reported for each sample of 0.014 mg/m^3. The current OSHA PEL for pentachlorophenol is 0.5 mg/m^3 determined as an 8-hour, TWA. The current ACGIH TLV for this compound is 0.5 mg/m^3, determined as an 8-hour, TWA. It was noted that both the OSHA PEL and ACGIH TLV carry a skin notation. It was noted that the type of Dowicide in use was in bead form. This form greatly reduces the potential for dust generation during handling.

Two personal samples were collected for two lift-truck operators to determine their exposure to carbon monoxide. One operated a lift truck in the upper powders area and the other in the lower powders area. Care was taken to select non-smokers since smoking could adversely effect the results of testing, causing high results. The results of these samples indicated 6.2 and 9.4 ppm carbon monoxide, determined as 8-hour, TWAs. The current OSHA PEL for carbon monoxide is 50 ppm, determined as an 8-hour, TWA. The current ACGIH 8-hour, TWA adopted TLV is 50 ppm. The recommended NIOSH PEL, determined as a 10-hour TWA is 35 ppm.

The daily production record for May 20, 1982 has been presented in Table 4.0-1. These records were obtained from Mr. Raymond Harrison (Powder House Supervisor) by William Ewing at the end of the shift on the day of sampling. An effort was made to procure the make-up of each compound in use; however, due to proprietory information this was not furnished to be included in this report. It should be noted that Mr. Ewing was informed that caustic soda and sodium pentachlorophenate would be used at mixer No. 5 on the day of the survey.

4.2. LOCAL EXHAUST VENTILATION

Ventilation measurements were taken on each of the hoods for the six mixing stations. This included face velocity measurements on each local exhaust hood at the lower powders drum filling stations and front and rear face velocity measurements at the upper powder compounding stations. Upper powders compounding station No. 3 was not available for testing due to maintenance activities at this location which would have invalidated any test results. The results of these measurements have been compiled and are presented in Tables 4.0-2 and 4.0-3.

PRODUCTION DATA
for May 20, 1982

(as reported to William Ewing by Raymond Harrison of
Zep Manufacturing Company on May 20, 1982)

Mixer No.	Batches	Weight Per Batch	Total Weight	Substance
3	8	1750 pds	14,000 pds	F-10 hand cleaner
4	2	1750 pds	3500 pds	Superflash
4	8	1750 pds	14,000 pds	Flash
5	1	1750 pds	1750 pds	1455
5	1	597 pds	597 pds	8375
5	1	600 pds	600 pds	8871
5	1	1750 pds	1750 pds	X21567
5	1	1752 pds	1752 pds	ZECO-60
5	2	1750 pds	3500 pds	14472
5	2	1750 pds	3500 pds	ZECO-20
5	2	1750 pds	3500 pds	Sewer Aid FA
6	45	250 pds	11,250 pds	ZORB

Table 4.0-2

VENTILATION MEASUREMENTS
Upper Powders - Compounding Hoods

Ventilation Measurement Location	HOOPER NUMBER 1		2		3		4		5		6	
	Front	Back	Front	Back	Front	Back	Front	Back	Front	Back	Front	Back
A ft/min	150	100	130	130			100	80	130	100	110	110
B ft/min	180	105	160	160	Not		130	80	100	130	110	120
C ft/min	130	100	130	120	Available		80	50	100	40	75	65
D ft/min	140	100	120	140	for		80	40	100	80	85	80
E ft/min	105	75	100	100	Testing		80	30	90	30	70	50
F ft/min	110	75	100	100			70	30	90	80	60	80
Avg. Face Velocity (ft/min)	140	90	120	130			90	50	100	80	90	80
Approx. Exhaust Volume (CFM)	2500	1500	2300	2000			1700	800	1900	1200	1600	1400
Hood Size (sq. ft.)	18.7	16.3	18.7	16.3			18.7	16.3	18.7	16.3	18.7	16.3
Approx. Total Exhaust Volume (CFM)	4000		4300				2500		3100		3000	

Table 4.0-3

VENTILATION MEASUREMENTS

Lower Powders - Mixer Dispensing Hoods

Velocity Measurement Location	MIXER NUMBER					
	1	2	3	4	5	6
A ft/min	50	110	40	90	80	190
B ft/min	110	100	60	50	100	240
D ft/min	100	180	40	50	60	180
E ft/min	80	110	60	50	60	150
F ft/min	60	120	60	80	60	110
G ft/min	60	60	40	50	30	100
H ft/min	100	100	25	25	30	110
I ft/min	80	100	35	40	40	200
J ft/min	80	90	30	25	30	150
Average Face Velocity (Ft/min)	80	110	40	50	50	160
Approx. Total Exhaust Volume (CFM)	1400	1900	770	900	960	1500
Hood Size (Sq. ft.)	17.7	17.7	17.7	17.7	17.7	9.6

The results of personal air sampling indicate that existing local exhaust ventilation at the drum filling and compounding stations is adequate to maintain employee exposure to selected contaminants below current OSHA limits at the production level during the day of the survey. The highest dust concentrations were found at the #3 and #4 dispensing hoods located in the lower powders area. Ventilation measurements indicated these hoods to have the lowest average face velocity of the six hoods in the lower powders area (Table 4.0-3). The design of the system allows the exhausts from hoods not in use to be shut off thereby increasing the velocity at the other stations. On the day of the survey all the dampers were open on all hoods of the upper and lower powders. The dampers should only be open on the hoods being used. It was noted that each damper was fitted with a counterweight which facilitates opening and closing the dampers. Each damper will need to be cleaned in order to obtain a good seal at the opening to the exhaust duct.

An inspection was made of the interior of the exhaust ductwork at several locations. It was noted that dust build-up in the ducts were in some areas an inch or more in depth. This dust reduces the overall effectiveness of the system by creating turbulance in the duct thereby reducing the air velocity. This reduced air velocity, in turn, allows more dust to accumulate in the ductwork, aggrevating the problem. A regular schedule of maintenance should be established to remove built-up deposits from the interior of the ductwork. It was noted that sufficient access doors are already in place for this purpose.

Smoke tubes were used to check for any dead air spaces or reverse flow on each hood. No dead air spaces were found on any hoods in the upper or lower powders area. Similarly, no instances of reverse flow could be found in either area. It was noted that man cooling fans on the upper powders level successfully compete with the exhaust ventilation at the hoppers. At the present time the fans must be turned off every time a bag or bulk material is dumped into the hopper. Since both open sides of each hopper must be accessible the man cooling fans blow air completely through each hopper. One solution to this problem would be to install sliding doors (vertical) on each hopper so that only one side is open at any one time.

The purpose of the three hoods situated between each pair of drum filling stations in the lower powders area is unclear. Each drum filling station is equipped with local exhaust ventilation which draws dusts and other contaminants away from the worker. These three hoods, located above the employees' work stations tend to pull air from the drum filling area toward the workers breathing zone. This flow competes with the local exhaust ventilation. The exhaust from these three hoods is connected to the same system as the local exhaust; by discontinuing their use the exhaust at the drum filling stations would increase.

4.3 GENERAL VENTILATION

On the day of the survey general ventilation appeared adequate. This was probably due to the number of doors which remained open to allow make-up air into the workplace to replace the air exhausted by the many local

exhaust hoods located on both levels. Due to the concern over possible build-up of exhaust fumes from the two lift trucks operating in the powders department, area carbon monoxide measurements were taken continuously during the day of the survey. A copy of the strip-chart recording is included in Appendix A. It was noted that carbon monoxide concentrations ranged from less than 5 ppm to 92 ppm (short duration) with concentrations in the range of 10-20 ppm most common. The measurements collected in the lower powders area are higher than normal since the lift-truck operator allowed his truck to idle near the monitor regardless of where it was placed. For this reason, the results from the lower powders area appear more typical of actual concentrations.

Based on these carbon monoxide measurements the potential exists for the build-up of carbon monoxide when doors and other sources of ventilation are shut, as may be the case in the colder months. Several actions can be taken to minimize the occurance of carbon monoxide build-up. The best recommendation would be to switch to electric lift-trucks. However, since this is not always feasible other recommendations are offered. Most importantly, lift-truck oerpators should be instructed that they are not to leave their engines idling when not in use. All lift-trucks should be properly tuned to reduce carbon monoxide and other emissions. Each of these recommendations will also save fuel.

4.4 NOISE MEASUREMENTS

Noise dosimetry and instantaneous A-weighted sound level measurements were conducted to determie employees 8-hour exposure to noise (A-weighed). The results of five noise dosimetry measurements indicated equivalent 8-hour noise exposures ranging from less than 70 to 79 dBA. Hand held, A-weighted sound level measurements did not exceed 83 dBA at any location in the powders department. Based on these data it is not likely that any employee would be exposed to noise in excess of the current 8-hour OSHA PEL (90 dBA) or "action level" (85 dBA). The results of all noise measurements, including dosimetry has been included in Appendix B (Tables B-1 and B-2).

4.5 MISCELLANEOUS

Observations of the upper and lower powders indicated housekeeping to be adequate with one exception. The exception being the storage of drums on the upper level which leak onto the floor. The contents of the drums should be clearly labeled and any precautions necessary also stated. All compounds in use should be labeled with their generic names and statements regarding use and precautions also included. It is anticipated that this will be required in the recently promulgated OSHA labeling standard when enforced. It should also be noted that employees will require training in the proper ways to handle the compounds they work with.

Several employees were observed wearing disposable respirators (Norton Model No. 7170, MSHA/NIOSH approval Nos. TC-21C-170 and TC-21C-170A). Although the use of these respirators is voluntary, any employee

wearing a respirator should be enrolled in a respiratory protection program which meets the requirements of the OSHA regulation 29 CFR 1910.134.

This Report Prepared By:

William M. Ewing
Industrial Hygienist

This Report Approved By:

James L. Burson, CIH
Industrial Hygienist
Manager, Occupational Safety and Health Branch

WME:JLB:sek

APPENDICES

APPENDIX A

RESULTS OF AIR SAMPLING

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Company
Atlanta, Georgia

Materials Total Dust (TD)
Sodium Hydroxide (NaOH)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			TD (mg/m^3)	NaOH (mg/m^3)
5/20/82	T-138-02	R. Harrison, Powders House Supervisor	0830	1607	909	457	0.50	<0.053
5/20/82	T-138-01	W. Freeman, Upper Powders, Mixers No. 5 & 6	0817	1600	921	463	0.78	0.066
5/20/82	T-138-03	T. Linder, Upper & Lower Powders Floor Manager	0836	1526	824	410	1.27	<0.058
5/20/82	T-138-05	W. McClure, Lower Powders Mixers No. 5 & 6	0803	1520	754	377	2.83	<0.064
5/20/82	T-138-04	D. Dewberry, Lower Powders Mixers No. 5 & 6	0807	1520	750	373	2.54	<0.064
5/20/82	T-138-07	D. Dewberry, Lower Powders Mixers No. 5 & 6	1528	1602	68	34	0.82	<0.71
5/20/82	PVC-138-04	R. Linton, Lower Powders Mixers No. 3 & 4	0830	1552	884	442	8.94	0.14
5/20/82	PVC-138-05	D. Harmon, Upper & Lower Powders Small Packaging Dept.	0852	1527	786	395	2.70	<0.061
5/20/82	PVC-138-02*	D. Langford, Lower Powders Mixers 3 & 4	0828	1552	810	440	Total Respirable Dust (mg/m^3) 3.85*	

*NOTE: Actual concentration of total respirable dust may be considerably lower. This was due to an increased pump flowrate causing the cyclone to operate improperly.

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Company
Atlanta, Georgia

Materials Pentachlorophenol (PCP)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			PCP (mg/m^3)	
5/20/82	AA-011-54	W. Freeman, Upper Powders Mixer No. 5	0817	1600	935	463	<0.011	
5/20/82	AA-011-22	D. Dewberry, Lower Powders Mixer No. 5	0807	1520	750	373	<0.013	
5/20/82	AA-011-52	W. McClure, Lower Powders Mixer No. 5	0803	1520	731	377	<0.014	

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

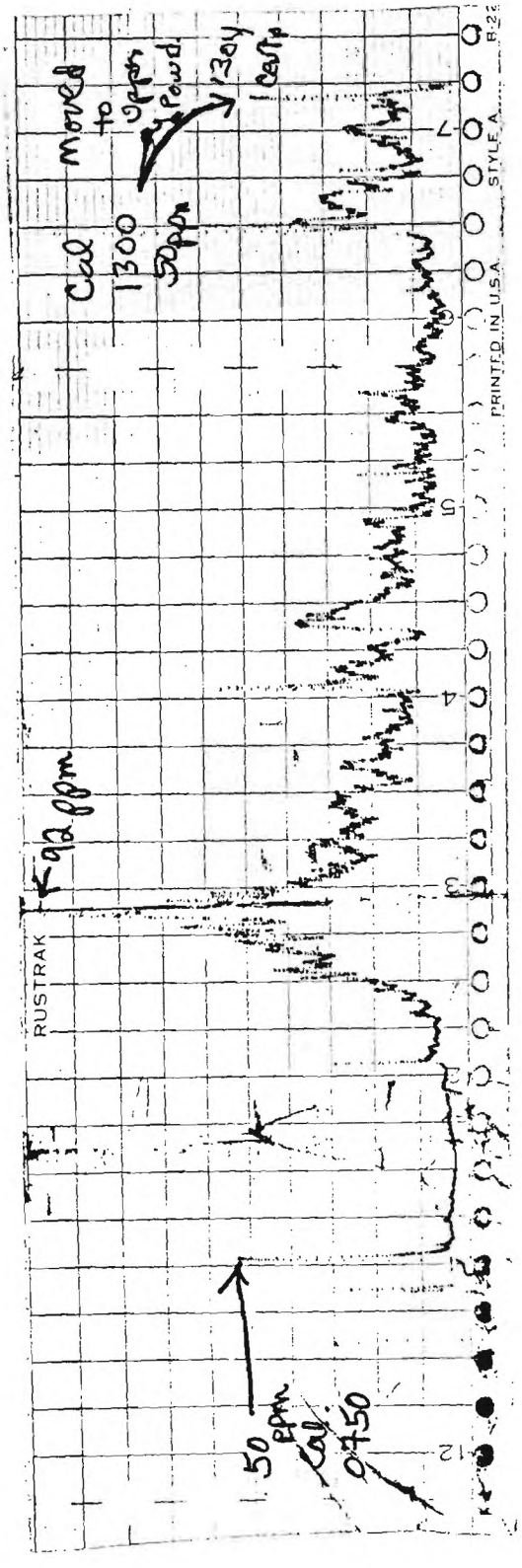
INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Company

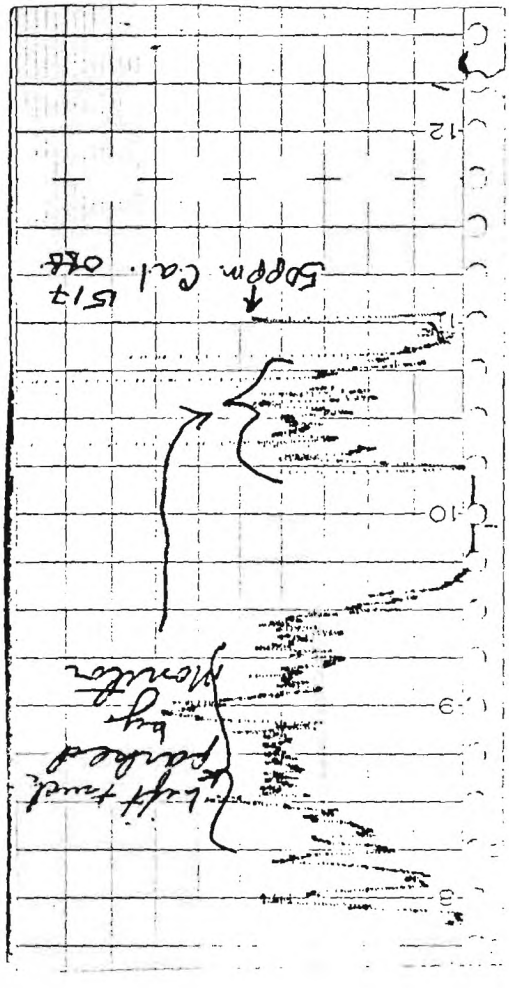
Atlanta, Georgia

Materials Carbon Monoxide (CO)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			CO (ppm)	
5/20/82	CO-1	W. H. Woods, Lower Powders	0856	1542	8.0	399	9.4	
		Lift Operator						
5/20/82	CO-2	W. Williams, Upper Powders	0858	1542	8.1	404	6.2	
		Lift Operator						



UPPER POWDERS



LOWER POWDERS

Dierct-Reading Carbon
Monoxide Measurements, May 20, 1982

Table A-4

APPENDIX B

RESULTS OF NOISE MEASUREMENTS

Table B-1

NOISE EXPOSURE DATA SHEET

Company ZEP Manufacturing Company Date May 20, 1982 Test by W. Ewing

Readout Model No. DuPont R-225 S/N 901507

Operating Conditions Normal Calibrator Model No. DuPont C-114 S/N 163085

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
7631	4533	Jerrial Weaver Lower Powders, #6 Mixer	0911 1540	6.48	0	<1	<70	NO
9686	4281	Harvey L. Thasher Maintenance Mech., Powders	0913 1602	6.82	19	22	79	NO
9690	4804	Leonard Walker Lower Powders, Mixer #4	0916 1540	6.40	15	19	78	NO
9693	4284	Rudolph Rainwater Lower Powders Lift Operator	0919 1600	6.68	1	1	<70	NO
9696	2165	Evlen Pendley Upper Powders Lift Operator	0921 1542	6.35	1	1	<70	NO

Table B-2

NOISE SURVEY DATA

PLANT: ZEP Manufacturing Company
LOCATION: Powders Department
INSTRUMENT: Gen Radio (S/N 1796) Type I SLM
DATE: May 20, 1982
BY: William M. Ewing

TIME	LOCATION	SPL (A-WEIGHTED)*
1215	Lower Powders, SM packaging dept.	73
1217	Lower Powders, Mixer #5	81
1218	Lower Powders, Mixer #3	83
1220	Product Storage (Powders)	68
1246	Upper Powders, Hopper #5	65
1248	Upper Powders, Hopper #3	66

*SPL = sound pressure level (dBA) - re 0.002 microbar

APPENDIX C

Sampling and Analytical Methods

CARBON MONOXIDE

Sampling for carbon monoxide (CO) was conducted by using the following two techniques.

Short-term area sampling (direct reading instantaneous) was performed either by drawing measured volumes of air through a length of stain detector tube via a hand-operated sampling pump, or by a direct-reading meter.

In the detector tube system, the CO indication is based upon the reduction of potassium palladosulfite impregnated silica gel giving a color change of yellow to brown in the presence of CO. The length of stain of the detector chemical is proportional to the CO concentration (in ppm) and must be matched to a chart corresponding to the number of pump strokes employed (1 full stroke = 100 cc) on the instruction sheet which accompanies the tubes.

The basic principle of operation of the direct reading meter involves drawing air (pre-cleansed to remove interferences) through an electrochemical sensor cell at a nominal flowrate of 700 cc/minute. The sensor cell is composed of a catalytically active sensing electrode (platinum), a counter electrode, a reference electrode and an aqueous sulfuric acid solution as the electrolyte. In the direct reading meter, the electrochemical process is carried out at a potential-controlled electrode. The current measured upon introduction of CO to the sensor cell is the result of the electro-oxidation of CO to carbon dioxide (CO_2) and is proportional to the partial pressure of CO in the sampled air.

NOISE

Sound pressure level measurements were taken with Type II Sound Level Meters manufactured in accordance with the American National Standards Institute (ANSI) SI.4 - 1971 "Specifications for Sound Level Meters". General area and operator station sound pressure levels were measure on the "A-weighted slow response" integrating network, which approximates the response of the normal human ear to sound, at the workers' ear level as specified in ANSI SI.13 - 1971 "Methods for the Measurement of Sound Pressure Levels".

When industrial noise is transient and variable, a reasonably accurate determination of compliance with existing standards can be made with an Audio Dosimeter which automatically time-weights and integrates the various exposure conditions. Readings from this devise are reported as a percentage of the current allowable exposure limit and have been corrected to reflect eight-hour, time-weighted averages. A representative number of sound level readings are taken while the dosimeters are being used in order to verify the dosimetry percentage readings.

The first step in the engineering control of industrial noise requires a comprehensive characterization of all major sources of noise, including an analysis of the individual sound pressure levels in the 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16000 using approved Octave Band Analyzers.

All noise instruments were calibrated in accordance with the manufacturers' recommendations prior to and immediately following use. Sound level meters were calibrated using the appropriate Sound Level Calibrators.

NOISE DOSIMETRY

Noise dosimetry studies of employee noise exposures were made using DuPont, Model D-376, Audio Dosimeters, set for a 90 dBA cutoff.

Sound levels reaching the employee were detected by a non-directional ceramic microphone worn on the shirt collar. This input is attenuated using the "A" weighting scale described in the American National Standards Institute S1.4-1971 "Type 2 Specification". If the microphone picks up any continuous sound over 115 dBA, it is recorded and stored for later inspection.

Next, noise below the cutoff level, 90 dBA, is removed on a continuous basis. The ratios of actual exposure to established limits at every sound level between 90 and 115 dBA are calculated and integrated with time to give the actual exposure during the workday as a percentage of that permitted by the regulations.

Data storage is accomplished by means of an electroplating reaction that occurs within an integrating memory cell. The information is stored in the cell until it is retrieved in a DuPont, Model R-225 readout instrument by reversing the electroplating reaction. The memory cell is automatically cleaned for reuse as the exposure information is retrieved.

Prior to use, the Audio Dosimeter battery is checked with an internal battery check and calibrated at two sound levels with a DuPont, Model C-114, calibrator.

TOTAL DUST

Samples to be analyzed for total dust were collected by drawing air at measured flowrates through cassetted polyvinyl filters, using battery-powered, portable pumps.

The mass of particulate matter collected on each filter was determined gravimetrically in the laboratory as the difference between the tare weight of the filter and the weight of the filter after sampling and equilibrium to balance room conditions.

Analytical results, which include any necessary corrections for blank determinations, were used in conjunction with the measure flowrates and sampling durations to calculate the concentrations of airborne analyte, expressed in unit of milligrams of analyte per cubic meter of air (mg/m^3).

APPENDIX D

Toxicological Information On Contaminants Sampled

CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless gas generally produced by incomplete combustion of organic or carbonaceous materials. It is a serious hazard in many processes in the chemical, iron and steel, pottery, automobile, and mining industries.

Of all the gases that have poisonous effects upon man and animals, carbon monoxide is the most widely encountered. It exerts its effects by combining with the hemoglobin of the blood and interrupting the normal oxygen supply to the body tissues. Although this resultant oxygen deficiency is a reversible chemical asphyxia, nevertheless, damage done by severe asphyxia from any cause may not be reversible.

The acute effects of carbon monoxide exposures are dependent on the percentage saturation of hemoglobin with carbon monoxide, which in turn is dependent on the duration of exposure, concentration of carbon monoxide, the ambient temperature, and the health status and metabolic efficiency of the worker. The approximate relationship is shown in the following table.

Atmospheric Carbon monoxide concentration (ppm)	Half-time for accumulation (min)	Carboxy-hemoglobin concentration at equilibrium %	Principal Symptoms
50	150	7	Slight headache
100	120	12	Moderate headache and dizziness
250	120	25	Severe headache and dizziness
500	90	45	Nausea, vomiting collapse possible
1,000	60	60	Coma
10,000	5	95	Death

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established a permissible exposure limit (PEL) for an eight-hour, time-weighted average, (TWA) exposure of 50 ppm to maintain carboxyhemoglobin levels below 10%. The National Institute for Occupational Safety and Health recommends a time-weighted average exposure of 35 ppm for an eight-hour workday, with a ceiling concentration of 200 ppm. ACGIH currently lists as "tentative value" a short-term exposure limit (up to 15 minutes) of 400 ppm.

NOISE

The major potential health hazard associated with exposure to noise lies in the possibility of producing permanent hearing loss. Factors which play a role in deciding how much permanent hearing loss will be sustained after exposure to high noise levels include the level and frequency of the noise, the duration of exposure per day, the number of years of repeated daily exposure, and individual susceptibility (age, genetic make-up, diet, and use of autotoxic drugs are just some of the variables which determine individual susceptibility).

The other adverse effects suspected as being caused by high noise levels include physiological disturbances (high blood pressure, aural pain, nausea and impaired muscular control when exposure is severe), and an increase in the accident frequency rate resulting from interference with speech communication and the disrupting of concentration. Also, some temporary hearing loss results from daily exposure to high noise levels, reportedly because the hair cells in the inner ear become fatigued and can no longer respond as well.

The standard as set by the Occupational Safety and Health Administration (OSHA) is based on daily time-weighted average exposure limits (over an eight-hour period) which, it is thought, will protect most workers from serious hearing loss.

The elements of the OSHA standard are:

1. The acceptable level of continuous noise (amplitude peaks less than one second apart) for exposures of eight hours duration is 90 decibels (dB) as measured on the A-weighted integrating network of a Type II sound level meter set on slow response, which approximates the response of the normal human ear to sound.

2. For each additional 5 dBA above 90, the permissible exposure time is reduced by half (see Table 1 below).

TABLE 1

PERMISSIBLE NOISE EXPOSURES

Sound Level (dBA)	Duration Hours/Day
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼ or less

3. No exposure to continuous noise levels in excess of 115 dBA is acceptable, regardless of duration.

4. Exposure to impulsive or impact noise (amplitude peaks greater than one second apart) in excess of 140 dB peak sound pressure level is unacceptable.

5. When workers are being overexposed on the basis of the criteria in Table 1, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

6. In all cases where the noise levels exceed an equivalent noise level of 85 dBA, including noise levels from 80 to 130 dBA, a continuing effective hearing conservation program shall be administered. The allowable duration of exposure is determined by the formula:

$$\text{Allowable time (Hours)} = \frac{32}{2^{(L-80)/5}}$$

where L is the sound level measured on the A weighted scale (dBA).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, as it is in most jobs in industrial settings, the combined effect shall be considered, rather than the individual effect of each. This combined effect, or total exposure, is determined by the following exposure formula.

$$\text{Exposure} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \cdots + \frac{C_n}{T_n}$$

Where C_n is the actual time spent at sound level, n (in dBA), and T_n is the allowable time spent at sound level, n.

OSHA has defined an effective hearing conservation program, but parts of the definition have been stayed. The portions which have not been stayed are summarized below:

1. Baseline audiometric testing must be completed by August 22, 1982, and repeated annually thereafter. All audiograms must be kept for the duration of employment.

2. Audiometric tests must be given by a trained individual and the audiometer must meet the ANSI S3.6-1969 criteria. Audiometer calibrations must be done as stated in the OSHA standard.

3. Audiograms showing a significant threshold shift must be reviewed by an audiologist, otolaryngologist, or qualified physician.

4. Employees must be notified of audiogram results within 21 days of receipt of the results. Hearing protection must be worn by employees having a significant threshold shift when working in areas where noise levels exceed 85 dBA.

5. Employees exposed to an equivalent noise level of 85 dBA or greater must have annual training which includes discussions of the effects of noise on man, the use of hearing protection, and audiometric testing.

6. When employees are exposed to greater than 90 dBA a written plan to reduce noise exposures to less than an equivalent noise level of 90 dBA must be formed. The plan may include both engineering and administrative controls.

NUISANCE DUST

In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics:

(1) The architecture of the air spaces remains intact.

(2) Collagen (scar tissue) is not formed to a significant extent.

(3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by rigorous skin cleansing procedures necessary for their removal. They do not appear to have a predisposing effect on tuberculosis or other infection and do not cause impaired lung function.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established time-weighed average (TWA) threshold limit values of 30 mppcf (millions of particles per cubic foot of air), based on impinger samples counted by light-field techniques or 10 mg/m^3 of total dust containing less than 1% quartz, or 5 mg/m^3 respirable dust. The Occupational Safety and Health Administration (OSHA) has established TWA standards of 50 mppcf or 15 mg/m^3 for total dust containing less than 1% quartz, or 15 mppcf or 5 mg/m^3 for respirable dust.

Quite often an industrial hygienist will use a gravimetric analysis for total dust when sampling for dusts with unknown toxicity. While the results may be compared to the nuisance dust standard for a base line reading, the dusts of unknown toxicity should in no way be considered nuisance dusts because the potential for harm has not been established.

PENTACHLOROPHENOL

Pentachlorophenol (PCP) is considered a toxic compound whose toxicity may vary depending upon the type and quantity of contaminants present. Samples were not adequately characterized until recently when some insoluble contaminants were recognized to be highly toxic polychlorinated dibenzodioxins and furans. Due to the difficulty of separating the isomers and in obtaining standards for analyses, there are many gaps in the toxicity data, creating uncertainty in any evaluation of the potential hazard.

An attempt must be made to differentiate between the clinical and pathological effects of PCP, the related phenols, and its likely contaminants, reported as (1) hexa-, hepta-, and octachlorodibenzodioxins and (2) hexa-, hepta-, and octachlorodibenzofurans. In addition there may be chlorophenoxyphenols and chlorinated diphenyl ethers (reported in European samples) whose identification, amounts, and toxicity have not been evaulated.

In general, acute exposure of animals has led to rapid development of high body temperature, increased respiratory rate, moderately elevated blood pressure, hyperglycemia, and muscle weakness, terminating in asphyxial convulsions with cardiac arrest, which tends to occur in less than 24 hours. Pathological examinations showed extensive damage to the cardiovascular system.

Most chlorinated dibenzodioxins, on the other hand, show a very different clinical picture. Oxidative phosphorylation is not affected. The effects are usually delayed (several weeks to months) and may be accompanied by effects on the liver, the hemopoietic system, and the lymphatic system with thymic atrophy and lymphoid depletion. There is a marked increase in liver microsomal enzyme activity and eventual histological change. There is a striking difference in susceptibility among species, the guinea pig being the most susceptible and the female being more susceptible than the male.

Experience has shown that dermal absorption is the primary hazard to man from the use of PCP as a wood preservative. The chemical has a low vapor pressure and is a respiratory irritant which acts as a warning. No complaints have been noted when the concentration is less than the TLV. In the United States there have been no reports of chronic injury to workers exposed as long as 35 years while manufacturing this material. Deaths and injuries have arisen from mishandling of the material in the wood treatment process.

The current Occupational Safety and Health Administration Permissible Exposure Limit for Pentachlorophenol in air is 0.5 mg/m^3 based on an 8-hour, TWA. The same value has been set as the Threshold Limit Value by the American Conference of Governmental Industrial Hygienists.

SODIUM HYDROXIDE

Sodium hydroxide (or caustic soda, NaOH) is an odorless, white strongly alkaline substance, which is soapy to the touch, dissolves freely in water with the evolution of heat, is deliquescent, and in the moist state absorbs carbon dioxide. Eye injury has been the most severe effect from contact with sodium hydroxide. Damage to the skin, loss of hair, and injury of mucous membranes have also been severe. Sodium hydroxide, in solid form or concentrated liquid solution, has a more corrosive local action on the tissue than do most acids. Contact with the eye can be particularly disastrous, causing severe damage to corneal tissue which may result in blindness. Inhalation of the dust or of mists formed from concentrated solutions of sodium hydroxide may cause pronounced upper respiratory irritation and, in the case of prolonged severe exposures, erosion of the nasal passages. Ingestion is followed by pain in the mouth, esophagus, and gastroenteric tract, vomiting, diarrhea, collapse, and coma.

The Occupational Safety and Health Administration (OSHA) has established, as a standard for occupational exposure, an eight-hour, time-weighted average concentration limit of two mg/m^3. Based on the prevention of strong irritant effects, the American Conference of Governmental Industrial Hygienists (ACGIH) has recommended a ceiling concentration of two mg/m^3, not to be exceeded for any length of time. The National Institute for Occupational Safety and Health (NIOSH) has recommended a standard of two mg/m^3 for any 15-minute sampling period.

A-3261

INDUSTRIAL HYGIENE SAMPLING SURVEY
at
ZEP MANUFACTURING COMPANY
1310 Seaboard Industrial Boulevard, N.W.
Atlanta, Georgia
for
MCLAIN AND MERRITT, P.C.
1250 Tower Place
Atlanta, Georgia 30026-3901

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Occupational Safety and Health Branch
Atlanta, Georgia
September 10, 1982

CONTENTS

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Project No. A-3261
September 9, 1982

1.0 INTRODUCTION

At the request of Mr. Robert Hill of McLain and Merritt, P.C., an industrial hygiene sampling survey was conducted at the acid house of ZEP Manufacturing Company's 1310 Seaboard Industrial Boulevard, N.W., Atlanta, Georgia facility. The survey was conducted by Mr. William M. Ewing of the Georgia Institute of Technology, Engineering Experiment Station, on August 10, 1982.

The purpose of the survey was to determine employee exposure to selected chemical compounds in use on the day of the survey. Further, work practices, including the use of personal protective equipment and housekeeping practices were reviewed. Ventilation measurements were also taken to evaluate existing local exhaust systems in the acid house. The following report summarizes the results of this survey including conclusions and recommendations.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 Conclusion - The employee working on the compounding floor is exposed to acid gases (hydrogen fluoride) in excess of the Occupational Safety and Health Administration (OSHA) permissable exposure limit (PEL).

2.2 Conclusion - The employee performing drum filling of acids is exposed to acid gases in excess of the cumulative OSHA PEL for hydrogen fluoride and hydrogen chloride.

2.3 Conclusion - The existing local exhaust system in use at the compounding floor, bottle filling, and drum filling is not balanced, undersized, and does not effectively control the release of acid gases into the work area.

2.4 Conclusion - Employees working at the bottle filling area and labeling area were not exposed to acid gases in excess of the current OSHA PEL for hydrogen chloride and hydrogen fluoride.

2.5 Conclusion - The wearing of protective equipment is not strictly enforced.

2.6 Conclusion - Employees in the acid house were not exposed to sulfuric acid mist over the OSHA PEL for this compound.

2.7 Conclusion - The wall fans and numerous open doors and windows effectively compete with the local exhaust system.

2.8 Conclusion - The open door (elevated) between the compounding floor and the main room presents a fall hazard to the compounder working on the upper level.

2.9 Conclusion - Housekeeping is not adequate, especially in the areas of drum filling and the two compounding levels.

2.10 Conclusion - Dripping condensed acids from the upper compounding level to the lower presents an acid burn hazard to employees or other persons who might enter the area.

2.11 Conclusion - Eye wash stations were not accessible in many instances and two were cluttered with debris.

2.12 Conclusion - Fire exits were often blocked by drums or other materials.

2.13 Conclusion - The compounder wore the proper respirator (at times) approved for use in atmospheres containing acid gases by the National Institute for Occupational Safety and Health (NIOSH).

2.14 Conclusion - The employee filling drums did not wear any respiratory protection equipment on the day of the survey.

2.15 Conclusion - The efforts to neutralize spilled acid immediately surrounding the neutralization tank was successful up to a distance of approximately 20 feet from the tank where the pH of the soil is less than 2 (very acidic).

2.16 Conclusion - Employees issued respirators are not properly trained in their use and maintenance and are not enrolled in a respiratory protection program.

2.17 Conclusion - Although employees working in the acid house are enrolled in a medical surveillance program, certain medical tests are not routinely performed.

2.18 Conclusion - Security at the acid house does not prevent outsiders from entering areas where hazardous compounds are present. It was noted that an apartment complex is located approximately 200 yards north of the acid house where children are present.

2.19 Recommendation - The employee filling drums should be provided with respiratory protection until engineering controls and subsequent air sampling indicate exposures are below the OSHA PEL for acid gases (hydrogen fluoride and hydrogen chloride). A NIOSH or MSHA-approved respirator should be used such as that currently in use by the compounder.

2.20 Recommendation - Employees wearing respirators should be enrolled in a respiratory training program which meets the requirements of the OSHA regulations (29 CFR 1910.134). A copy of this regulation is attached as Appendix D.

2.21 Recommendation - In addition to the current medical surveillence, acid house employees should receive annual uninary fluoride analyses, skin and cornea examinations, and x-ray of the pelvis of males. The physician evaluating the x-ray films should be made aware of the fluoride exposure and should have knowledge of the radiologic signs of osteofluorosis.

2.22 Recommendation - Any employees exposed to hydrogen fluoride and exhibiting signs or symptoms of respiratory tract irritation should be examined by a physician and should have follow-up chest x-rays taken and pulmonary function tests performed as considered necessary by the examining physician.

2.23 Recommendation - Workers with eye complaints following exposure to acid gases should have follow-up visual acuity tests and ophthalmological examination as necessary.

2.24 Recommendation - The following scheme of biological monitoring is recommended by NIOSH for urinary fluoride determinations.

Postshift fluoride urinalysis should be made available at intervals not exceeding 3 months to at least one-fourth of all workers with occupational exposure to hydrogen fluoride. The employer should ensure that each exposed worker has the opportunity of receiving a fluoride analysis of his urine every year. Spot urine samples shall be collected at the conclusion of the workshift after 4 or more consecutive days of exposure. Urinary preshift fluoride analysis should be made available to all exposed workers at least annually. Preshift spot samples shall be collected at the start of the workshift at least 48 hours after the last occupational exposure. Results shall be calculated to a specific gravity of 1.024. Urine specimens with a specific gravity less than 1.010 shall be discarded and another specimen obtained. If an individual's postshift urinary fluoride level exceeds 7.0 mg/liter, preshift spot urine samples for analysis shall be collected within 2 weeks at the start of a workshift at least 48 hours after a previous occupational exposure and a repeat postshift spot sample for analysis shall be collected at the conclusion of the workshift. This should be done at the end of the workweek in which the preshift sample is collected. If the fluoride elvel of the second sample is above either the preshift limit of 4.0mg/liter or the postshift limit of 7.0 mg/liter, steps should be taken to evaluate dietary soruces, personal hygiene, basic work practices, and environmental controls.

Urine samples should be collected in chemically clean bottles containing 0.2 g of EDTA. If the volume of the urine sample as determined upon receipt is greater than 100 ml, an amount of EDTA equivalent to 0.2 g/100 ml in excess of the first 100 ml should be added. Care must be taken when collecting and handling urine specimens to avoid fluoride contamination. Upon receipt of the sample, either analyze immediately or refrigerate to retard bacterial action on urea which increases the simple pH through the generation of ammonia. Determine the specific gravity before analysis. Transfer 10 ml of well-mixed urine sample and 10 ml of TISAB into a 50-ml plastic beaker and stir with a magnetic stirrer. Proceed directly with electrode analysis. Determine fluoride concentration by referring to a previously prepared standard curve. Calculate to mean specific gravity of 1.024. If a urinometer is used which

has been calibrated against water at 4 C, a temperature correction must be made.

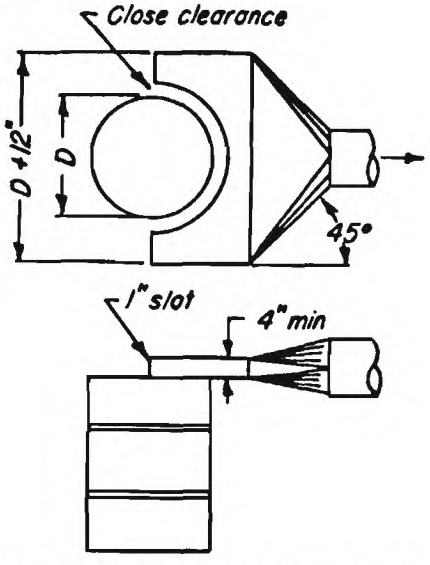
2.25 Recommendation - The wearing of respirators by the compounder and drum filler should be strictly enforced until levels of acid gases are reduced below the OSHA PEL.

2.26 Recommendation - The wearing of all required personal protective clothing should be enforced for all employees in the acid house. This includes boots, aprons, goggles, gloves, and arm (sleeve) covering. Note: Sleeve covering should be worn over the glove to prevent liquid acids from dripping inside the glove.

2.27 Recommendation - Eye wash stations and showers should be accessable at all times, fully operational, and free of debris.

2.28 Recommendation - Fire exits and aisles should not be blocked at any time.

2.29 Recommendation - A permanent drum filling station should be considered. Such a station would be equipped with local exhaust ventilation to capture acid gases as they are emitted. This would eliminate the need for moving the dispensing hose from drum-to-drum where leakage occurs. Further, the station should be equipped with a scale so the employee knows when the drum is full. This would eliminate the need for the employee to peer into the drum through the vent or stick his fingers into the drum. For ease of handling, dollies could be used for moving drums to and from the station. Below is a suggested ventilation design for such a station, although the ideal station would only be open on one side and would be a box shape with the scale in the floor.



Q = 100 cfm/sq ft barrel top min
Duct velocity = 3500 minimum
Entry loss = 0.25 VP + 1.78 slot VP
Mcnual loading.

Figure 2.0-1

2.30 Recommendation - The existing local exhaust system provides enough ventilation for the drum filling exhaust, vat #1, and the two measuring kettles. A second system (fan and scrubber) would be necessary to increase the local exhaust at vats 2 and 3, and the small packaging area. It is important that any ventilation or local exhaust system be properly sized and balanced. Further, make-up air should be supplied to the upper compounding floor.

2.31 Recommendation - The wooden steps and floor in the upper compounding floor are slippery due to acid condensation on these surfaces. Consideration should be given to installing a floor and stairs composed of fiberglass-reinforced plastic. If a grating is chosen the make-up air referred to in 2.31 could be drawn through the floor. This type of floor would also facilitate cleaning.

2.32 Recommendation - The upper level door between the main room and the compounding floor should have a railing or chain to reduce the chance of a serious fall.

2.33 Recommendation - The area around the acid neutralization tank should be diked to contain any overflow. The dike should be large enough to collect run-off from the acid tanks located immediately north of the building. The dike should have a impermeable plastic liner to prevent leaching or seeping of acids into the soil and subsequently into the ground water.

2.34 Recommendation - A security system should be devised to prevent the public from entering areas containing hazardous materials. In the area of the acid house this would include the gulch immediately west of the acid house and the weed killer test plots east of the acid house. Such a system (fence or other) would reduce the possibility of children or others from being harmed by corrosive chemicals in the area.

2.35 Recommendation - The wall fan located in the south wall (east end) should be repaired. It appeared that a bearing needed replacing or the belt tightened.

2.36 Recommendation - Dripping acid from condensation on overhead pipes poses a hazard to persons entering the lower level of the compounding level. A fiberglass-reinforced trough placed below the pipes and draining into the neutralization tank would reduce the hazard.

2.37 Recommendation - Housekeeping throughout the acid house should be improved. Spills should be cleaned up immediately and leaks repaired promptly.

3.0 DESCRIPTION OF OPERATIONS

ZEP Manufacturing Company is engaged in the production of commercial, institutional, and industrial chemicals for use in sanitation and maintenance. Products include liquids, powders, and a wide variety of aersols and sprays which are used as waxes, polishes, water treatment chemicals, deodorants, cleaners, disinfectants, degreasers, weed killers,

insecticides, and for other purposes. The Atlanta facility manufacturers approximately 90% of the product range offered by ZEP Manufacturing. The facility consists of five production areas, warehouse facilities, quality control laboratory, and the general offices. The scope of this industrial hygiene survey was limited to the acid house.

3.1 ACID HOUSE

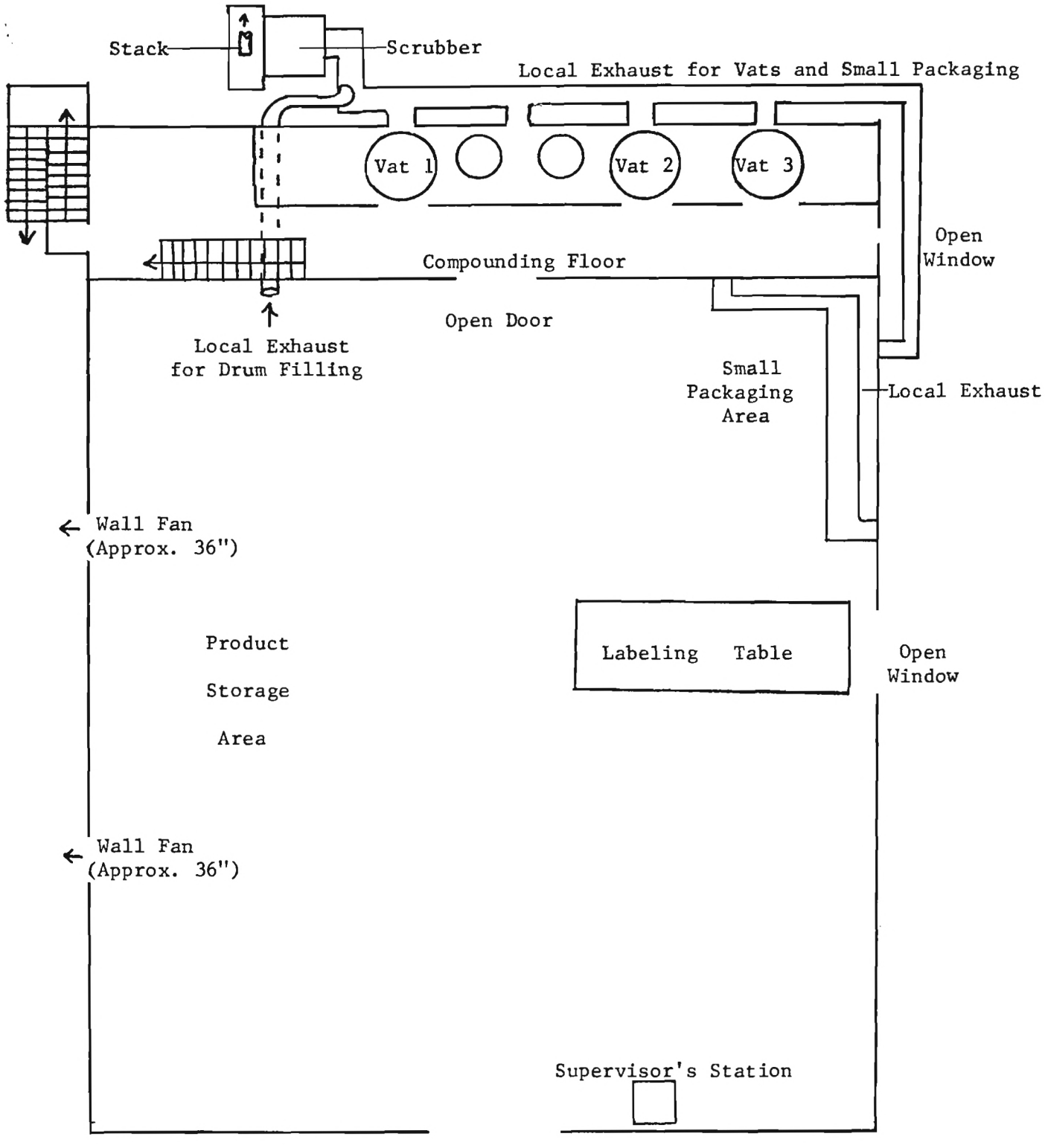
The acid house (Figure 3.0-1) is located to the extreme northeast of the ZEP facility. It consists of the mixing area, filling and packaging area, and the drum storage area beneath a canopy adjacent to this facility. One person accomplishes all the tasks of mixing the acids on the upper level of the northwest end of the building. These tasks include pumping acids from three bulk storage tanks located northeast of the flammable liquids house into two graduated holding tanks in the center of the mixing station. The acid from these tanks is introduced directly into one of three mixing vats. Other components may then be added manually through openings in the top of the vats before mixing. The acid is drawn from the tanks through plastic pipe to the drum filling area located in the northwest corner of the main room. One person fills the drums, and purges the hose between batches. Normally, one batch would supply about 300-400 gallons. A small container packaging line is located in the northeast corner of this facility. One person fills the containers (1 pint-1 gallon each) using a mechanized dispensor. Two to three other employees label the containers and place them into boxes for storage. The most commonly used acids are hydrochloric (muratic), hydrofluoric, sulfuric, and phosphoric.

4.0 DISCUSSION OF FINDINGS

4.1 EMPLOYEE EXPOSURE TO ACID GASES

Eleven samples were collected and analyzed for various acid gases and mists which were suspected on the day of the survey. Three products were formulated and packaged on August 10, 1982. These were formula 6556, ZEP-FLO, and ZEPCOREX. The formula 6556 and ZEPCOREX contain hydrocloric acid and hydrofluoric acid. ZEP-FLO contains, among other acids, sulfuric acid. Since sulfuric acid represents less of an inhalation hazard due to its low volatility, sampling and analyes emphasized exposure to hydrogen chloride and hydrogen fluoride which are readily given off by their respective liquid acids. Personal and area air samples were collected at selected points to estimate the employee's exposure. The individual sample results are included in Tables A-1 and A-2 of Appendix A.

Two personal samples were collected in the breathing zone of the compounder and analyzed for hydrogen chloride and hydrogen fluoride gases. The hydrogen chloride concentration ranged from 0.90 to 1.03 mg/m^3 with an 8-hour TWA value of 0.97 mg/m^3, which is below the current OSHA PEL of 7 mg/m^3. It was noted that the highest area air sample indicated a hydrogen chloride concentration of 2.15 mg/m^3. Two



ACID HOUSE
ZEP MANUFACTURING CO.
Atlanta, Georgia
August 10, 1982

Figure 3.0-1

personal samples collected in the breathing zone of the compounder indicated hydrogen fluoride concentrations of 0.76 and 3.41 mg/m^3, respectively. The 8-hour, TWA concentration calculated for the compounder was 2.19 mg/m^3, in excess of the current OSHA PEL of 2 mg/m^3 hydrogen fluoride, determined as an 8-hour, TWA. Three area samples collected and analyzed for hydrogen fluoride indicated a range of values from 4.45 to 14.4 mg/m^3. From these data it is clear that the source of hydrogen fluoride are the vats located at the north end of the compounding floor. Based on the area and personal samples it may be concluded that the compounder is regularly exposed to hydrogen fluoride gas in excess of the current OSHA PEL, the NIOSH recommended PEL (both 8-hour, TWA and ceiling values)and the ACGIH TLV. It should be noted here that this employee was observed wearing a respirator at times when in the mixing area.

Two personal samples were collected in the breathing zone of the employee filling 55 gallon drums with ZEP formula 6556. The analyses revealed concentrations of 2.94 and 3.72 mg/m^3 hydrogen chloride gas for the two samples and hydrogen fluoride concentrations of 0.90 and 0.98 mg/m^3, respectively. This results in 8-hour, TWA concentrations of hydrogen chloride and hydrogen fluoride of 3.54 and 0.96 mg/m^3, respectively. Although the individual OSHA limits for these two compounds were not exceeded, the cumulative limit was equaled and may easily be exceeded during periods of increased production in the acid house.

Two personal and one area air sample were collected at the bottling filling area to estimate exposure to hydrogen chloride and hydrogen fluoride gases. The two personal samples indicated 0.36 and 1.74 mg/m^3 hydrogen chloride and 0.46 and 0.74 mg/m^3 hydrogen fluoride. The 8-hour, TWA concentrations of hydrogen chloride and hydrogen fluoride were 0.94 and 0.58 mg/m^3 respectively. These values do not exceed the individual OSHA PELs established for these gases. Further, the cumulative value does not exceed the limit for these two compounds which have similar effects on the body. One area sample collected at the bottle capping station indicated 0.76 and 0.78 mg/m^3 of hydrogen chloride and hydrogen fluoride, respectively. The results of each individual sample area included in Table A-1 of Appendix A.

One area sample was collected at the north end of the compounding floor to estimate exposure to sulfuric acid mist when ZEP-FLO was being mixed. The result of analysis indicated less than 0.01 mg/m^3 sulfuric acid. This value is below the current OSHA PEL for sulfuric acid mist of 1 mg/m^3, determined as an 8-hour, TWA. This low concentration is probably due to the low vapor pressure of sulfuric acid (0.001 mm Hg).

Eight short-term area samples were taken at selected areas of the acid house to estimate concentrations of hydrogen chloride and hydrogen fluoride. These results are compiled in Table A-3 of Appendix A. These data compare very closely with those obtained using the impinger technique of measuring hydrogen chloride and hydrogen fluoride.

4.2 VENTILATION

Ventilation measurements were taken on the day of the survey to estimate the effectiveness of the existing local exhaust system and determine general ventilation air flows. Local exhaust ventilation measurements were made using a thermal anemometer and smoke tubes. Smoke tubes alone were used to estimate air-flow patterns.

Table 4.2-1 is a summary of the local exhaust ventilation measurements. It should be noted that all local exhaust pick-ups connect to a common duct located at the west end of the building (outside). This duct feeds exhaust air into a scrubber to remove acid gases before emitting them to the air. The data suggest the system is not balanced and undersized to meet the requirements necessary to reduce the acid gas concentration below acceptable levels. Compounding the problem is competition from open windows, doors, and two wall fans located in the south wall of the building.

The data and area sampling suggest that the existing system provides adequate local exhaust ventilation for the drum filling and vat no. 1. If the duct distal to the measuring vats was disconnected from the system it would likely provide enough local exhaust at the two measuring vats as well. An additional fan and scrubber would be necessary to provide the exhaust at vats 2 and 3, and the bottle filling area. Both systems would need to be properly balanced. The conclusions and recommendations section of this report provides additional information regarding ventilation and the drum filling procedures.

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WME:JLB:sek

TABLE 4.2-1

SUMMARY OF VENTILATION MEASUREMENTS

Location	Avg. Face Velocity (ft/min)	Hood Opening (ft^2)	Total Exhaust Volume (CFM)
Kettle #1	112	10.7	1200
Kettle#2	27	5.0	135
Kettle #3	20	5.0	100
Drum Filling Local Exhaust	2500	0.20	490
Measuring Vats (2)	28	25.5	710

APPENDIX A

RESULTS OF AIR SAMPLING

Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Company (Acid House)
Atlanta, Georgia

Materials Hydrogen Chloride (HCl)
Hydrogen Fluoride (HF)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			HCl (mg/m^3)	HF (mg/m^3)
8/10	A-1	F. Ray, Compounder	0838	1112	154	154	1.03	3.41
8/10	A-9	F. Ray, Compounder	1300	1512	132	132	0.90	0.76
8/10	A-8	A. Fuller, Drum Filling #6556	1117	1158	41	41	2.94	0.90
8/10	A-11	A. Fuller, Drum Filling #6556	1303	1521	138	138	3.72	0.98
8/10	A-2	J. Manago, Filling Bottles with ZEPCOREX	0846	1142	176	176	0.36	0.46
8/10	A-10	J. Manago, Filling Bottles with ZEPCOREX and ZEP-F10	1303	1510	127	127	1.74	0.74
8/10	A-4	Area sample, north end of compounding room	1000	1035	35	35	2.15	10.5
8/10	A-5	Area sample, center of compounding room	1038	1053	15	15	1.79	14.4
8/10	A-6	Area sample, south end of compounding room	1055	1110	15	15	<0.7	4.45
8/10	A-3	Area sample, on bottle capping machine, filling area	0848	1142	174	174	0.76	0.78

Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Company (Acid House)
Atlanta, Georgia

Materials Sulfuric Acid Mist (H_2SO_4)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			H_2SO_4 (mg/m^3)	
8/10	AA-300	Area sample, south end of compounding floor, mixing ZEP-FLO in Vat #3	1308	1518	260	130	<0.01	

TABLE A-3

SHORT-TERM AREA ACID GAS MEASUREMENTS
(All samples taken with Bendix colorimetric indicating tubes)

Sample Number	Description	Results
ST-01	North End of Compounding Floor	7 ppm HF
ST-02	South End of Compounding Floor	2 ppm HF
ST-04	Bottle Filling Area	1 ppm HF
ST-06	South End of Compounding Floor	2 ppm HCl
ST-07	North End of Compounding Floor	15 ppm HCl
ST-08	Bottle Filling Area	1 ppm HCl
ST-09	Drum Filling (Zep Formula 6556)	2 ppm HF
ST-10	Drum Filling (Zep Formula 6556)	6 ppm HCl

APPENDIX B

SAMPLING AND ANALYTICAL METHODS

HYDROGEN CHLORIDE
(HCl)

Integrated long term samples of Hydrogen Chloride were collected by drawing air at measured flowrates (nominal 1 liter per minute) through all-glass midget impingers containing either 15 ml of distilled water or 15 ml of 0.1 N sodium hydroxide absorbing solution using battery-powered, portable pumps. After collection, the impinger solutions were immediately transferred into glass bottles and sealed with Teflon lined caps for transport to the laboratory.

The samples were prepared for analysis by buffering. Laboratory analysis was accomplished by measuring the total soluble chloride content in an aliquot of each sample determined by comparison of the relative responses of an ion-selective electrode to the prepared samples and to aqueous chloride standards prepared in a like manner. Results of analysis (calculated as HCl) were used in conjuction with sampling data to calculate the airborne concentrations of hydrogen chloride (in mg/m^3). The reported results of sampling include any necessary correction for blank and recovery determinations run in parallel with the analysis.

HYDROGEN FLUORIDE (HF)

Integrated, long-term samples were collected by drawing air at measured flowrates (nominal 1.0 liters per minute) through all glass midget impingers containing 15 ml of 0.1 N sodium hydroxide absorbing solution using battery-powered portable sampling pumps. After collection, the impinger solutions were immediately transferred into glass bottles and sealed with teflon lined caps for transport to the laboratory.

The samples were prepared for analysis by buffering. Laboratory analysis was accomplished by measuring the total soluble fluoride content in an aliquot of each sample determined by the relative responses of an ion-selective electrode to the prepared samples and to aqueous fluoride standards prepared in a like manner. Results of analysis (calculated as HF) were used in conjunction with sampling data to calculate the airborne concentrations of hydrogen fluoride (in mg/m^3). The reported results of sampling include any necessary correction for blank and recovery determinations run in parallel with the analysis.

SULFURIC ACID

Integrated, long-term samples for sulfuric acid mist were collected by drawing air at measured flowrates (nominal 2.0 liters per minute) through 37-mm cellulose ester membrane filters (Millipore, Type AA).

In the laboratory, the filter samples were extracted with distilled water; the sulfuric acid content of each filter was determined by 1:4 dilution with isopropanol and subsequent titration with barium perchlorate solution using Thorin indicator. Results of analysis were used in conjunction with sampling data to calculate airborne concentrations of sulfuric acid (in mg/m^3). The reported results of sampling include any necessary corrections for blank and recovery determinations run in parallel with the analysis.

APPENDIX C

TOXICOLOGICAL INFORMATION ON CONTAMINANTS SAMPLED

HYDROGEN CHLORIDE

Hydrogen chloride (HCl) is a colorless gas having a characteristic irritating, pungent odor. It has such a sharp odor, that the inhalation of seriously toxic quantities is unlikely.

Anhydrous hydrogen chloride has a highly corrosive action upon the skin and mucous membranes due to the rapid absorption of the gas on these surfaces, forming hydrochloric acid. Either the liquid or gas will therefore cause burns, if in contact with any part of the body. If taken by mouth, the acid may injure the gastro-intestinal tracts, whereas breathing the vapor or mist may injure the respiratory tract.

The acid so formed neutralizes the alkali of the tissue and, in cases of massive inhalation exposure, can cause death due to pulmonary edema or spasm of the larynx and inflammation of the upper respiratory system. Work is impossible when one inhales air containing hydrogen chloride in concentrations of 50 to 100 ppm; work is difficult but possible when the air contains concentrations of 10 to 50 ppm; and work is generally undisturbed at concentrations below 10 ppm although 5 to 10 ppm is disagreeable to some workers. Prolonged exposure to low concentrations causes erosion of the teeth. Contact of the eyes with hydrogen chloride, either as a gas or in solution, rapidly causes severe irritation of the eyes and eyelids. If the acid is not quickly removed by thorough irrigation with water, there may be prolonged or permanent visual impairment or total loss of sight.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established a standard for occupational exposure to five ppm (which is designated as a ceiling concentration, i.e., that value to which exposure should not be permitted for any length of time) which is interpreted as sufficiently low to prevent toxic injury, although irritation may be experienced by some individuals.

HYDROGEN FLUORIDE

Hydrogen fluoride (HF) is a colorless liquid, with boiling point 19.5°C. Its acqueous solution attacks glass, concrete, and certain metals, especially those containing silica, such as cast iron. It also attacks natural rubber, leather and many organic materials.

Hydrogen fluoride is strongly corrosive. Both the liquid and vapor are dangerous when in contact with the eyes, skin, or mucous membranes and, if taken by mouth, the liquid will have a corrosive effect on the gastrointestinal tract. Either the liquid or vapor in contact with any part of the body may immediately cause serious and extremely painful burns.

Hydrogen fluoride vapor is extremely irritating to all parts of the respiratory tract. Severe exposure will lead to rapid inflammation and congestion of the lungs. The concentration which produces acute effects varies with exposure; fifty ppm or more may be fatal when breathed for 30 to 60 minutes. If swallowed, hydrogen fluoride will immediately cause severe irritation of and damage to the esophagus and the stomach. Coincidentally, severe irritation to the respiratory tract will also occur. Contact of liquid, or vapor with eyes rapidly causes severe irritation and deep-seated burns of the eyes and eyelids. If the hydrogen fluoride is not rapidly removed by thorough irrigation with water, there may be prolonged or permanent visual defects or total loss of vision and destruction of the eyes. Nosebleeds and sinus troubles have reportedly occurred among metal workers exposed to low concentrations. Continuous or repeated exposure to low concentrations of hydrogen fluoride vapor can result in excessive deposition of fluoride in bone (skeletal fluorosis or osteofluorosis).

To prevent long term chronic effects, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of three ppm (two mg/m^3) as a standard for occupational exposure.

The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of 2.5 mg/m^3 (as F) for up to a ten-hour work day, 40-hour work week, with a ceiling concentration limit of five mg/m^3 (as F) for 15 minutes to prevent (a) acute irritation of the skin, eyes, and respiratory tract, and (b) chronic deleterious effects of skeletal fluorosis.

SULFURIC ACID

Sulfuric acid (H_2SO_4) is a clear, colorless oily liquid when pure but brownish in hue when impure; it is odorless and has a marked acid taste. Sulfuric acid is a strong acid which, when heated to above 30°C, gives off vapor and, above 200°C, emits sulfur tricoxide.

The action of sulfuric acid on the body is that of a powerful corrosive and general toxic agent. Introduced into the body in liquid or vapor form, it causes intense irritation and chemical burns of the mucous membranes of the respiratory and digestive tract, the teeth, the eyes and skin. On contact with the skin, sulfuric acid causes violent dehydration and releases heat in sufficient quantities to produce burns that are similar to thermal burns.

The depth of the lesions depends on the concentrations of the acid and the length of contact. Inhalation of vapors produces the following symptoms: nasal secretion, sneezing, a burning feeling in the throat and retrosternal region; these are followed by cough, respiratory distress, sometimes accompanied by spasm of the vocal cords, a burning sensation in the eyes with lacrimation and conjunctival congestion. High concentrations may cause bloody nasal secretion and sputum, hematemesis, gastritis, etc. Dental lesions are common; they affect mainly the incisors and result in brown staining enamel striation, caries and rapid and painless destruction of the tooth crown.

Chemical burns are the injury most commonly encountered in sulfuric acid production workers. Concentrated solutions cause deep burns of mucous membrances and skin; initially the zone of contact with the acid is bleached and turns brown prior to the formation of a clearly defined ulcer on a light red background. These wounds are long in healing and may frequently cause extensive scarring that results in functional inhibition. If burning is sufficiently extensive, the outcome may prove fatal. Repeated skin contact with low concentrations of acid causes skin desiccation and ulceration of the hands, and panaris or chronic purulent inflammation around the nails. Splashes of acid in the eyes may have particularly serious consequences.

The general toxic action of sulfuric acid causes alkaline depletion of the body, i.e., an acidosis which affects the nervous system and produces agitation, hesitant gait and generalized weakness.

To prevent irritation of respiratory passages and injury to the teeth, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average concentration limit of one mg/m^3 as an acceptable limit for occupational exposure to sulfuric acid. The National Institute for Occupational Safety and Health (NIOSH) has also proposed a one mg/m^3 level of exposure time-weighted average over an eight-hour work day.

APPENDIX D

REQUIREMENTS FOR A RESPIRATORY PROTECTION PROGRAM

OCCUPATIONAL SAFETY AND HEALTH STANDARDS
SUBPART I — PERSONAL PROTECTIVE EQUIPMENT

(Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, 36 FR 10466, May 29, 1971; amended at 36 FR 15105, August 13, 1971; 37 FR 22231, October 18, 1972; republished at 39 FR 23502, June 27, 1974; standard provision revoked at 43 FR 49726, October 24, 1978)

Subpart I—Personal Protective Equipment

§ 1910.132 General requirements.

(a) *Application.* Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

(b) *Employee-owned equipment.* Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

(c) *Design.* All personal protective equipment shall be of safe design and construction for the work to be performed.

§ 1910.133 Eye and face protection.

(a) *General.* (1) Protective eye and face equipment shall be required where there is a reasonable probability of injury that can be prevented by such equipment. In such cases, employers shall make conveniently available a type of protector suitable for the work to be performed, and employees shall use such protectors. No unprotected person shall knowingly be subjected to a hazardous environmental condition. Suitable eye protectors shall be provided where machines or operations present the hazard of flying objects, glare, liquids, injurious radiation, or a combination of these hazards.

(2) Protectors shall meet the following minimum requirements:

(i) They shall provide adequate protection against the particular hazards for which they are designed.

(ii) They shall be reasonably comfortable when worn under the designated conditions.

(iii) They shall fit snugly and shall not unduly interfere with the movements of the wearer.

(iv) They shall be durable.

(v) They shall be capable of being disinfected.

(vi) They shall be easily cleanable.

(vii) Protectors should be kept clean and in good repair.

(3) Persons whose vision requires the use of corrective lenses in spectacles, and who are required by this standard to wear eye protection, shall wear goggles or spectacles of one of the following types:

(i) Spectacles whose protective lenses provide optical correction.

(ii) Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles.

(iii) Goggles that incorporate corrective lenses mounted behind the protective lenses.

(4) Every protector shall be distinctly marked to facilitate identification only of the manufacturer.

(5) When limitations or precautions are indicated by the manufacturer, they shall be transmitted to the user and care taken to see that such limitations and precautions are strictly observed.

(6) Design, construction, testing, and use of devices for eye and face protection shall be in accordance with American National Standard for Occupational and Educational Eye and Face Protection, Z87.1–1968.

§ 1910.134 Respiratory protection.

(a) *Permissible practice.* (1) In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

(2) Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protective program which shall include the requirements outlined in paragraph (b) of this section.

(3) The employee shall use the provided respiratory protection in accordance with instructions and training received.

(b) *Requirements for a minimal acceptable program.* (1) Written standard operating procedures governing the selection and use of respirators shall be established.

(2) Respirators shall be selected on the basis of hazards to which the worker is exposed.

(3) The user shall be instructed and trained in the proper use of respirators and their limitations.

(4) Where practicable, the respirators should be assigned to individual workers for their exclusive use.

(5) Respirators shall be regularly cleaned and disinfected. Those issued for

xclusive use of one worker should be ed after each day's use, or more if necessary. Those used by more one worker shall be thoroughly ed and disinfected after each use. Respirators shall be stored in a nient, clean, and sanitary location. Respirators used routinely shall spected during cleaning. Worn or orated parts shall be replaced. Res- rs for emergency use such as self- ined devices shall be thoroughly ted at least once a month and after se.

Appropriate surveillance of work conditions and degree of employee ire or stress shall be maintained.

There shall be regular inspection valuation to determine the con- effectiveness of the program.

Persons should not be assigned s requiring use of respirators un- has been determined that they are ally able to perform the work and e equipment. The local physician etermine what health and physical ions are pertinent. The respirator medical status should be review i ically (for instance, annually).

Approved or accepted respirators be used when they are available. espirator furnished shall provide ate respiratory protection against articular hazard for which it is ed in accordance with standards shed by competent authorities. The epartment of Interior, Bureau of and the U.S. Department of Agri- are recognized as such authori- lthough respirators listed by the epartment of Agriculture continue acceptable for protection against ed pesticides, the U.S. Department Interior, Bureau of Mines, is the now responsible for testing and ing pesticide respirators.

Selection of respirators. Proper on of respirators shall be made ac- g to the guidance of American al Standard Practices for Respira- rotection Z88.2–1969.

Air quality. (1) Compressed air, essed oxygen, liquid air, and liquid used for respiration shall be of urity. Oxygen shall meet the re- ents of the United States Pharma- a for medical or breathing oxygen. ing air shall meet at least the re- ents of the specification for Grade thing air as described in Com- l Gas Association Commodity cation G–7.1–1966. Compressed shall not be used in supplied-air tors or in open circuit self- ed breathing apparatus that have sly used compressed air. Oxygen never be used with air line tors.

Breathing air may be supplied to tors from cylinders or air ssors

ylinders shall be tested and main- as prescribed in the Shipping ner Specification Regulations of partment of Transportation (49 art 178).

The compressor for supplying air e equipped with necessary safety andby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications in subparagraph (1) of this paragraph.

(3) Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

(4) Breathing gas containers shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1–1954; Federal Specification BB–A–1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG–B–00675b, April 27, 1965, Breathing Apparatus Self-Contained.

(e) *Use of respirators.* (1) Standard procedures shall be developed for respirator use. These should include all information and guidance necessary for their proper selection, use, and care. Possible emergency and routine uses of respirators should be anticipated and planned for.

(2) The correct respirator shall be specified for each job. The respirator type is usually specified in the work procedures by a qualified individual supervising the respiratory protective program. The individual issuing them shall be adequately instructed to insure that the correct respirator is issued. Each respirator permanently assigned to an individual should be durably marked to indicate to whom it was assigned. This mark shall not affect the respirator performance in any way. The date of issuance should be recorded.

(3) Written procedures shall be prepared covering safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies. Personnel shall be familiar with these procedures and the available respirators.

(i) In areas where the wearer, with failure of the respirator, could be overcome by a toxic or oxygen-deficient atmosphere, at least one additional man shall be present. Communications (visual, voice, or signal line) shall be maintained between both or all individuals present. Planning shall be such that one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to assist the other(s) in case of emergency.

(ii) When self-contained breathing apparatus or hose masks with blowers are used in atmospheres immediately dangerous to life or health, standby men must be present with suitable rescue equipment.

(iii) Persons using air line respirators in atmospheres immediately hazardous to life or health shall be equipped with safety harnesses and safety lines for lifting or removing persons from hazardous atmospheres or other and equivalent provisions for the rescue of persons from hazardous atmospheres shall be used. A standby man or men with suitable self-contained breathing apparatus shall be at the nearest fresh air base for emergency rescue.

(4) Respiratory protection is no better than the respirator in use, even though it is worn conscientiously. Frequent random inspections shall be conducted by a qualified individual to assure that respirators are properly selected, used, cleaned, and maintained.

(5) For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons. Training shall provide the men an opportunity to handle the respirator, have it fitted properly, test its face-piece-to-face seal, wear it in normal air for a long familiarity period, and, finally, to wear it in a test atmosphere.

(i) Every respirator wearer shall receive fitting instructions including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly. Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. Also, the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors shall be evaluated by periodic check. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturer's facepiece fitting instructions.

(ii) Providing respiratory protection for individuals wearing corrective glasses is a serious problem. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. As a temporary measure, glasses with short temple bars or without temple bars may be taped to the wearer's head. Wearing of contact lenses in contaminated atmospheres with a respirator shall not be allowed. Systems have been developed for mounting corrective lenses inside full facepieces. When a workman must wear corrective lenses as part of the facepiece, the facepiece and lenses shall be fitted by qualified individuals to provide good vision, comfort, and a gas-tight seal.

(iii) If corrective spectacles or goggles are required, they shall be worn so as not to affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

(f) *Maintenance and care of respirators.* (1) A program for maintenance and

care of respirators shall be adjusted to the type of plant, working conditions, and hazards involved, and shall include the following basic services:

(i) Inspection for defects (including a leak check),

(ii) Cleaning and disinfecting,

(iii) Repair,

(iv) Storage

Equipment shall be properly maintained to retain its original effectiveness.

(2) (i) All respirators shall be inspected routinely before and after each use. A respirator that is not routinely used but is kept ready for emergency use shall be inspected after each use and at least monthly to assure that it is in satisfactory working condition.

(ii) Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be fully charged according to the manufacturer's instructions. It shall be determined that the regulator and warning devices function properly.

(iii) Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, headbands, valves, connecting tube, and canisters. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration. Stretching and manipulating rubber or elastomer parts with a massaging action will keep them pliable and flexible and prevent them from taking a set during storage.

(iv) A record shall be kept of inspection dates and findings for respirators maintained for emergency use.

(3) Routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to insure that proper protection is provided for the wearer. Each worker should be briefed on the cleaning procedure and be assured that he will always receive a clean and disinfected respirator. Such assurances are of greatest significance when respirators are not individually assigned to workers. Respirators maintained for emergency use shall be cleaned and disinfected after each use.

(4) Replacement or repairs shall be done only by experienced persons with parts designed for the respirator. No attempt shall be made to replace components or to make adjustment or repairs beyond the manufacturer's recommendations. Reducing or admission valves or regulators shall be returned to the manufacturer or to a trained technician for adjustment or repair.

(5) (i) After inspection, cleaning, and necessary repair, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators placed at stations and work areas for emergency use should be quickly accessible at all times and should be stored in compartments built for the purpose. The compartments should be clearly marked. Routinely used respirators, such as dust respirators, may be placed in plastic bags. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons.

(ii) Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position and function will not be impaired by the elastomer setting in an abnormal position.

(iii) Instructions for proper storage of emergency respirators, such as gas masks and self-contained breathing apparatus, are found in "use and care" instructions usually mounted inside the carrying case lid.

(g) *Identification of gas mask canisters.* (1) The primary means of identifying a gas mask canister shall be by means of properly worded labels. The secondary means of identifying a gas mask canister shall be by a color code.

(2) All who issue or use gas masks falling within the scope of this section shall see that all gas mask canisters purchased or used by them are properly labeled and colored in accordance with these requirements before they are placed in service and that the labels and colors are properly maintained at all times thereafter until the canisters have completely served their purpose.

(3) On each canister shall appear in bold letters the following:

(i)—

Canister for _____
(Name for atmospheric contaminant)

or

Type N Gas Mask Canister

(ii) In addition, essentially the following wording shall appear beneath the appropriate phrase on the canister label: "For respiratory protection in atmospheres containing not more than ------ percent by volume of_____
_____."
(Name of atmospheric contaminant)

(iii) [Revoked]

(4) Canisters having a special high-efficiency filter for protection against radionuclides and other highly toxic particulates shall be labeled with a statement of the type and degree of protection afforded by the filter. The label shall be affixed to the neck end of, or to the gray stripe which is around and near the top of, the canister. The degree of protection shall be marked as the percent of penetration of the canister by a 0.3-micron-diameter dioctyl phthalate (DOP) smoke at a flow rate of 85 liters per minute.

(5) Each canister shall have a label warning that gas masks should be used only in atmospheres containing sufficient oxygen to support life (at least 16 percent by volume), since gas mask canisters are only designed to neutralize or remove contaminants from the air.

(6) Each gas mask canister shall be painted a distinctive color or combination of colors indicated in Table I-1. All colors used shall be such that they are clearly identifiable by the user and clearly distinguishable from one another. The color coating used shall offer a high degree of resistance to chipping, scaling, peeling, blistering, fading, and the effects of the ordinary atmospheres to which they may be exposed under normal conditions of storage and use. Appropriately colored pressure sensitive tape may be used for the stripes.

[Section 1910.134(g)(3)(iii) revoked at 43 FR 49726, October 24, 1978, 1978, effective November 24, 1978]

TABLE I-1

Atmospheric contaminants to be protected against	*Colors assigned**
Acid gases	White.
Hydrocyanic acid gas	White with ½-inch green stripe completely around the canister near the bottom.
Chlorine gas	White with ½-inch yellow stripe completely around the canister near the bottom.
Organic vapors	Black.
Ammonia gas	Green.
Acid gases and ammonia gas	Green with ½-inch white stripe completely around the canister near the bottom.
Carbon monoxide	Blue.
Acid gases and organic vapors	Yellow.
Hydrocyanic acid gas and chloropicrin vapor	Yellow with ½-inch blue stripe completely around the canister near the bottom.
Acid gases, organic vapors, and ammonia gases.	Brown.
Radioactive materials, excepting tritium and noble gases.	Purple (Magenta).
Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors.	Canister color for contaminant, as designated above, with ½-inch gray stripe completely around the canister near the top.
All of the above atmospheric contaminants	Red with ½-inch gray stripe completely around the canister near the top.

*Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

NOTE: Orange shall be used as a complete body, or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

[Sec. 1910.134(g)(6)]

15 Occupational head protec-

s for the protection of heads of
mal workers from impact and
on from falling and flying ob-
from limited electric shock and
ll meet the requirements and
ions established in American
Standard Safety Requirements
strial Head Protection, Z89.1–

6 Occupational foot protec-

toe footwear for employees
t the requirements and speci-
in American National Stand-
Men's Safety-Toe Footwear,
7.

7 Electrical protective devices.

protective equipment for elec-
kers shall conform to the re-
s established in the American
Standards Institute Standards
d in the following list:

Item	Standard
ulating gloves.	J6.6–1967.
atting for use lectric s.	J6.7–1935 (R1962).
Rubber insulating blankets.	J6.4–1970.
Rubber insulating hoods.	J6.2–1950 (R1962)
Rubber insulating line hose.	J6.1–1950 (R1962)
Rubber insulating sleeves.	J6.5–1962.

§ 1910.138 Effective dates.

(a) The provisions of this Subpart I shall become effective on August 27, 1971, except that:

(1) Any provision in any other section of this subpart which contains in itself a specific effective date or time limitation shall become effective on such date or shall apply in accordance with such limitation; and

(2) If any standard in 41 CFR Part 50–204. other than a national consensus standard incorporated by reference in § 50–204.2(a)(1), is or becomes applicable at any time to any employment and place of employment, by virtue of the Walsh-Healey Public Contracts Act, or the Service Contract Act of 1965, or the National Foundation on Arts and Humanities Act of 1965, any corresponding established Federal standard in this Subpart I which is derived from 41 CFR Part 50–204 shall also become effective, and shall be applicable to such employment and place of employment, on the same date.

§ 1910.139 Sources of standards.

Sec.	*Source*
1910.132	41 CFR 50–204.7.
1910.133(a)	ANSI Z87.1–1968. Eye and Face Protection.
1910.134	ANSI Z88.2–1969, Standard Practice for Respiratory Protection.
1910.134 Table I–I.	ANSI K13.1–1967, Indentification of Gas Mask Canister.
1910.135	ASNI Z89.1–1969, Safety Requirements for Industrial Head Protection.
1910.136	ANSI Z41.1–1967, Men's Safety-Toe Footwear.
1910.137	ANSI Z9.4–1968, Ventilation and Safe Practices of Abrasive Blasting Operations.

§ 1910.140 Standards organizations.

Specific standards of the following organization have been referenced in this part. Copies of the referenced materials may be obtained from the issuing organization.

American National Standards Institute, 1430 Broadway, New York, NY 10018.

A-3261

INDUSTRIAL HYGIENE SAMPLING SURVEY

at

ZEP MANUFACTURING COMPANY
1310 Seaboard Industrial Boulevard, N.W.
Atlanta, Georgia

for

MCLAIN AND MERRITT, P.C.
1250 Tower Place
Atlanta, Georgia 30026-3901

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Occupational Safety and Health Division
Atlanta, Georgia
October 20, 1982

Project No. A-3261

CONTENTS

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1.0 INTRODUCTION

At the request of Mr. Robert Hill of McLain and Merritt, P.C., an industrial hygiene sampling survey was conducted at the soaphouse and flammable liquids departments of ZEP Manufacturing Company's 1310 Seaboard Industrial Boulevard, N.W., Atlanta, Georgia facility. The survey was conducted by Mr. William M. Ewing of the Georgia Institute of Technology, Engineering Experiment Station, on August 18, 1982.

The purpose of the survey was to determine employee exposure to selected chemical compounds in use on the day of the survey. Further, work practices, including the use of personal protective equipment and housekeeping practices were reviewed. Ventilation measurements were also taken to evaluate existing local exhaust systems in these departments. The following report summarizes the results of this survey including conclusions and recommendations.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 Personal and area air samples collected in the soaphouse and flammable liquids house indicated employee exposure to a wide range of organic compounds. Although none of the results individually exceeded recommended guidelines, very little is known regarding the combined effect of all of these compounds on the worker. Accordingly, efforts should be applied to minimizing all exposures through the use of proper protective equipment (gloves, goggles, aprons, etc.) and adequate ventilation.

2.2 Due to the recent evidence linking methylene chloride to cancer in laboratory animals (study by National Toxicology Program reported in Chemical and Engineering News, October 4, 1982, p. 13), every effort should be made to minimize employee exposure to methylene chloride until further information is available.

2.3 Air sampling conducted during the compounding and dispensing of a product containing formaldehyde (formalin) revealed employee exposures below the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for formaldehyde. However, the results

indicated exposures above the National Safety Institute for Occuaptional Safety and Health (NIOSH) recommended limit. It should be noted that the OSHA limit was established prior to the implication of formaldehyde as a possible carcinogen.

2.4 Zep Manufacturing should consider the possible health effects resulting from the use of the formaldehyde-containing product "Big John". As a first step, formaldehyde concentrations should be measured under actual or simulated use to estimate user exposure to formaldehyde.

2.5 The presence of asbestos was confirmed on bulk storage tanks located between the flammable and upper liquids' areas. Asbestos does not present a hazard until it becomes airborne. Accordingly, the following procedures should be used during any maintenance activities which might disturb the material.

2.5.1 Employees should be thoroughly familiar with the hazards of asbestos and methods of insulation removal or repair which will minimize airborne emissions of asbestos fibers. This includes the use of wet methods.

2.5.2 The work area should be sealed from all other areas so that fibers generated during the removal operations will not be dispersed throughout the facility where unprotected employees are working. A polyethylene film enclosure works well for this.

2.5.3 A recent interpretation by OSHA of the asbestos standard requires that supplied-air (Type C) respirators be used during pipe demolition (or insulation removal) until air samples indicate that a respirator offering less protection is adequate.

2.5.4 Plastic film (at least 6 mil) should cover the grating beneath the work area to prevent asbestos-containing debris from falling through to other areas.

2.5.5 All asbestos-containing waste should be bagged while wet. The bag should be placed in a fiberboard drum for transportation to the disposal site. The drums may be reused.

2.5.6 Employees should be instructed to vacuum dust off their persons after removing their protective garments with a HEPA filtered vacuum. Immediately following this they should be instructed to shower. This will minimize the risk of bringing asbestos into the employee's home.

2.5.7 All other portions of the existing asbestos should be enforced, including requirements for the standard posting of warning signs and labeling the waste in accordance with OSHA and EPA regulations. A copy of these regulations is included in Appendix D of this report.

2.6 Personal samples indicated employee exposure to carbon monoxide was below the current OSHA PEL of 50 parts per million (ppm), determined as

an 8-hour, time-weighted average (TWA). These samples were collected for lift-truck operators. Area samples indicated a build-up of carbon monoxide occurs on the west side (old powders house) of the lower soaphouse.

2.7 Local exhaust ventilation was evaluated in the upper and lower soaphouse and the flammable liquids house. Recommendations for corrective actions are included in section 4.5.1 of this report.

2.8 General ventilation was found to be inadequate in the old powders area of the lower soaphouse. This allows for the build-up of organic vapors and carbon monoxide in this area. Recommendations for improvements are included in section 4.5.2.

2.9 Housekeeping practices need improvement in the soaphouse and flammable liquids house. Floor drainage can be improved in the lower soaphouse by building-up the perimeter and center areas to accelerate run-off.

2.10 Aisles in the upper and lower soaphouse should be kept clear at all times in case of fire or other emergency (chemical spill) requiring evacuation.

2.11 The use of personal protective equipment by all employees should be enforced.

2.12 Additional eye washes are needed in the gallon fill area and the old powders area. A shower should be installed in the old powders area and the one in the lower soaphouse drum filling area repaired.

2.13 A splash guard should be installed in the gallon fill area to protect employees from splashing when containers are overfilled.

3.0 DESCRIPTION OF OPERATIONS

ZEP Manufacturing Company is engaged in the production of commercial, institutional, and industrial chemicals for use in sanitation and maintenance. Products include liquids, powders, and a wide variety of aerosols and sprays which are used as waxes, polishes, water treatment chemicals, deodorants, cleaners, disinfectants, degreasers, weed killers, and insecticides. The Atlanta facility manufacturers approximately 90% of the product range offered by ZEP Manufacturing. The facility consists of five production areas, warehouse facilities, quality control laboratory, and the general offices. The scope of this industrial hygiene survey was limited to the soaphouse and flammable liquids departments.

3.1 UPPER LIQUIDS AREA

The upper liquid area (Figure 3.0-1) employs approximately 10 persons engaged in the mixing of the various components to produce liquid soaps and other liquid products. Some of the raw materials used in the process are stored at the extreme north and south ends of this area. The mixing

tanks are located on either side of a partition in the center of the area. The individual ingredients are added to each vat by dispensing from drums (predominantly 55 gallon) with the aid of propane-powered lift trucks. The range of chemicals used in this area varies depending upon the final product. Organic solvents, acids, and some caustics are commonly used. Some powders may be dissolved during mixing but the final product is always a liquid, or a semi-solid in the case of certain waxes.

3.2 LOWER LIQUIDS AREA

The lower liquids area (Figure 3.0.2) is located directly beneath the upper liquids mixing area. This area employs approximately 15 persons engaged in the drawing and packaging of these liquid products. This area may be further divided into the draw-off area and the packaging room. In the draw-off area quantities of the liquid products from the upper vats are piped directly into drums. In the packaging room the liquid products are packaged in smaller containers at either of the two packaging lines. As with the upper liquids area, the actual products in use vary as a function of supply of the current inventory and needs of the clients.

3.3 FLAMMABLE LIQUIDS HOUSE

The flammable liquid products house (Figure 3.0-1) is located adjacent to the upper liquids area and is composed of two rooms containing four mixing tanks. Practically all chemicals in use in this area are flammable. Most of these substances have a kerosene base. Under normal operations two persons work in this area.

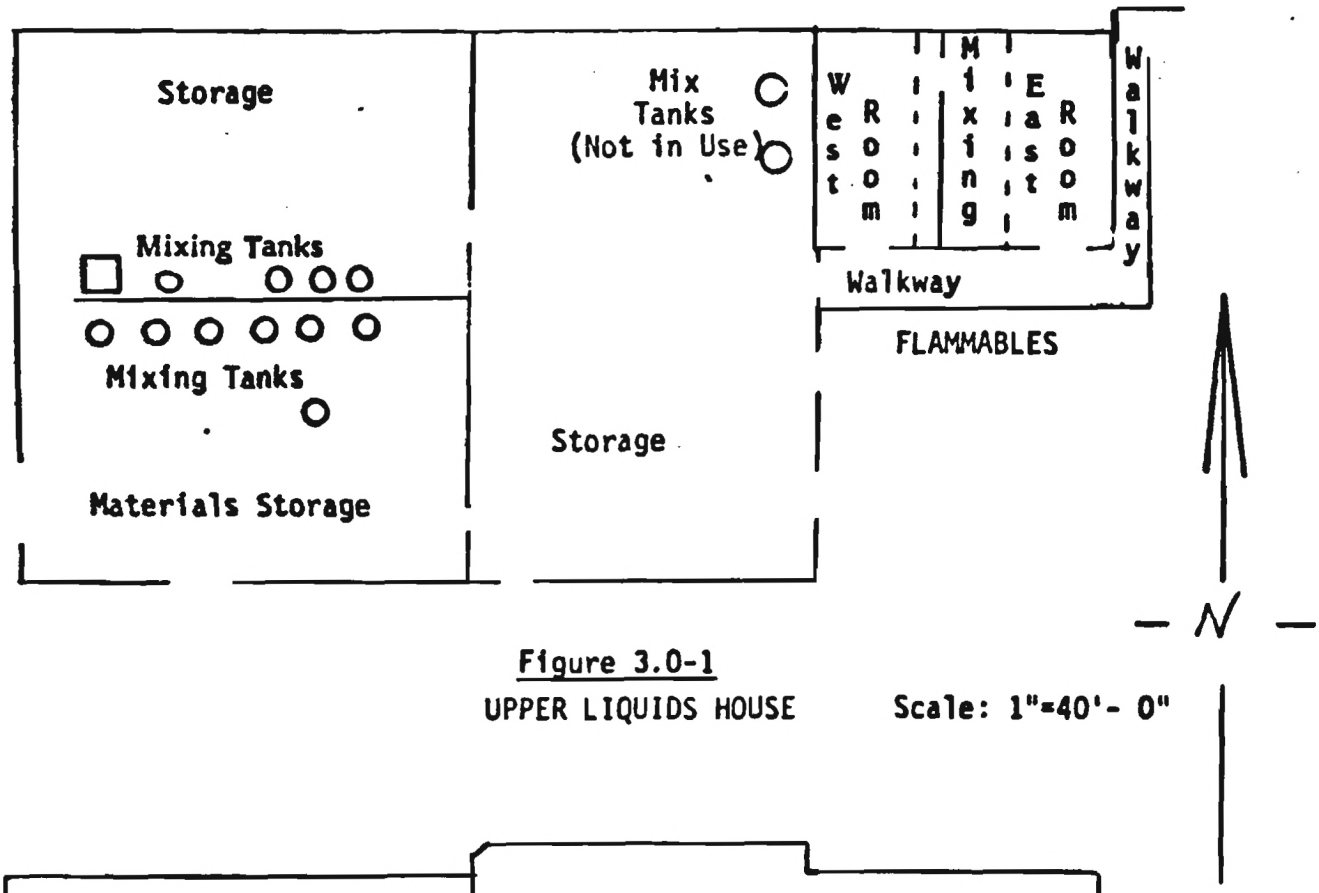


Figure 3.0-1
UPPER LIQUIDS HOUSE Scale: 1"=40'- 0"

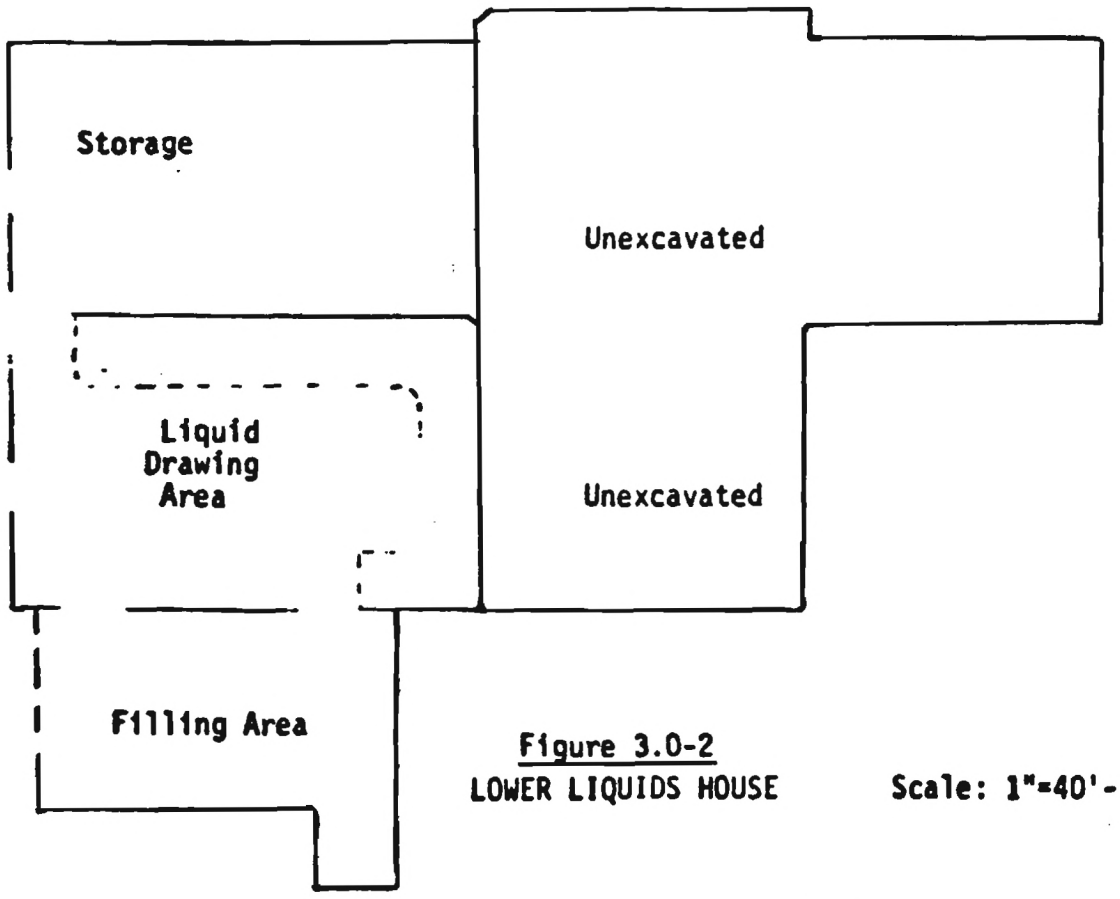


Figure 3.0-2
LOWER LIQUIDS HOUSE Scale: 1"=40'- 0"

ZEP MANUFACTURING COMPANY
Atlanta, Georgia

4.0 DISCUSSION OF RESULTS

4.1 AIR SAMPLING - ORGANIC COMPOUNDS

Personal and area air samples were collected and analyzed for a variety of organic compounds in use during the survey. Two personal samples were collected in the flammable liquids house. One of these was for the employee mixing (compounding) the products and the other for the lift-truck operator who works in flammable liquids and the upper soaphouse. Two additional personal samples were collected to determine employee exposure to selected organic compounds in the soaphouse. One of these employees worked in the upper soaphouse (compounder) and one in the lower soaphouse (drum filling). One area sample was also collected in the northwest corner of the lower soaphouse. Each of the samples were analyzed by gas chromatography for the following compounds.

n-hexane	Ethyl benzene
Hexane equivalent	p-ethyl toluene
1,2-epoxy butane	Trimethylbenzene
1,1,1-trichloroethane	C_8-C_{10} aromatic hydrocarbons
Methylene chloride	Butyl cellosolve
Perchloroethylene	o-dichlorobenzene
Toluene	p-dichlorobenzene
Xylenes	Isopropyl alcohol

The results of each sample analysis is included in Table A-1 of Appendix A. Although the 8-hour, OSHA PEL was not exceeded for any of the above chemical contaminants (where applicable), significant concentrations of some were detected. Table I reports the range of concentrations found, and applicable recommended standards for each compound. All values are representative of 8-hour, TWA exposures.

These data indicate the potential for exposure to a wide range of chemical compounds during any given day. This applies to the soaphouse and the flammable liquids house. Although none of the results individually exceeded recommended guidelines, very little is known regarding the combined effect of all of these compounds on the body. Accordingly, efforts should be applied to minimizing all exposures through the use of proper protective equipment (gloves, goggles, aprons, etc.) and adequate ventilation. These items are addressed in section 4.6 of in this report.

It should be noted that methylene chloride has recently been found to cause cancer in laboratory animals, according to the National Toxicology Program (Chemical & Engineering News, October 4, 1982, p. 13). The recommended limits in Table I were promulgated before this information was available. At the present time, further information regarding recommended actions has not been released by NIOSH or OSHA. Accordingly, every effort should be made to minimize employee exposure to methylene chloride until further information is available.

TABLE I

Range of Concentrations Found For Selected Chemical Contaminants

Contaminant	Range (parts per million)	OSHA PEL	NIOSH RPEL	ACGIH TLV
n-hexane	0.04 - 0.07	500	100	100
Hexane equivalent	1.15 - 2.49	-	-	-
1,2-epoxy butane	0.30 - 0.93	-	-	-
1,1,1-trichloroethane	0.81 - 51.7	350	350	350
Methylene chloride	5.59 - 37.4	500	75	100
Perchloroethylene	0.20 - 25.5	100	50	100
Toluene	0.07 - 2.10	200	100	100
Xylene	1.42 - 11.4	100	100	100
Ethyl benzene	0.12 - 0.95	100	-	100
p-ethyl toluene	0.29 - 2.52	-	-	-
Trimethylbenzene	0.26 - 2.26	-	-	25
C_8-C_{10} aromatics	0.60 - 3.74	-	-	-
Butyl cellosolve	0.13 - 1.95	50	-	25
o-dichlorobenzene	0.05 - 0.48	50	-	50
p-dichlorobenzene	0.03 - 3.01	75	-	75
Isopropyl alcohol	1.40 - 12.1	400	400	500

4.2 FORMALDEHYDE

Personal and area air samples were collected and analyzed to determine employee exposure to formaldehyde when compounding the product "Big John". It should be noted that the samples reflect an employee's short term (15-20 minutes) exposure and are not 8-hour TWAs. During the mixing of the product one employee was exposed to a concentration of 1.91 parts per million (ppm) formaldehyde for 21 minutes. An area sample taken during this same period indicated 2.02 ppm. The mix included 474 gallons of liquid formalin. A personal sample taken during drum filling of "Big John" indicated an exposure of 0.96 ppm formaldehyde for the 15 minutes taken to fill the four drums. An area sample collected on top of the drums indicated 2.62 ppm formladehyde during the same period.

None of the above samples indicated an exposure in excess of the current OSHA ceiling or peak limits of 5 and 10 ppm, respectively. Further, since this exposure was the only for the workday it can be concluded that neither employee was exposed in excess of the 3 ppm OSHA PEL, determined for an 8-hour, TWA.

Toxicology studies completed during the past two years by the Chemical Industry Institute of Toxicology (CIIT) have demonstrated that formaldehyde can cause cancer in laboratory animals. The OSHA limits cited above were established prior to this knowledge and therefore, did not take this information into account. The National Institute for Occupational Safety and Health (NIOSH) has established a recommended limit of 0.8 ppm during any 30-minute exposure. This value was exceeded for the two employees sampled. The ACGIH has published that it intends to change the adopted TLV from 2 ppm (8-hour, TWA) to a TLV recommending the lowest possible exposure.

The use of formaldehyde-emitting materials (products) has generated much concern and publicity recently, due to its role as a possible carcinogen. As a consequence, the Consumer Product Safety Commission (CPSC) has banned its use in insulating materials and is investigating its use in wood products (particleboard, paneling, etc.). Accordingly, Zep Manufacturing should consider the end use of any products, such as "Big John", which contain formaldehyde (or formalin). As a first step, formaldehyde concentrations should be measured under actual conditions where the product is used. If this is not feasible, it should be measured under simulated conditions. With this information, a reasonable conclusion may be drawn estimating the exposure of the user of the product.

4.3 ASBESTOS

Two bulk samples of tank lagging were collected and analyzed for the presence of asbestos. The samples were collected from the bulk storage tanks located between the flammable and upper liquids' areas. Four of these tanks were noted having insulation. The results indicated the lagging contains 10% chrysotile asbestos. The lagging has begun to deteriorate and has been repaired several times.

Asbestos is recognized to be a human carcinogen and is capable of producing asbestosis, lung cancer, tumors, and mesothelioma. Accordingly, precautions must be taken to protect employees performing work on asbestos-containing materials and other people in the vicinity of such work. Both OSHA and EPA have regulations regarding asbestos-containing materials. Each have requirements to be followed during removal or major maintenance on asbestos insulation or other asbestos-containing materials. Copies of these regulations are included in Appendix D of this report. Section 2.0 of this report contains recommendations to protect employees during any future work involving asbestos-containing materials.

4.4 CARBON MONOXIDE

Personal and area air samples were collected to determine employee exposure to carbon monoxide. The source of the carbon monoxide is powered lift-trucks operating in the soaphouse. It was noted that the lift-truck in the flammable liquids area is electric and therefore does not present a carbon monoxide hazard. The two personal samples indicated 9.6 and 24 ppm carbon monoxide. These samples were taken for the upper and lower soaphouse lift-truck operators, respectively, and represent 8-hour, TWA exposures. The current 8-hour, TWA OSHA PEL for carbon monoxide is 50 ppm.

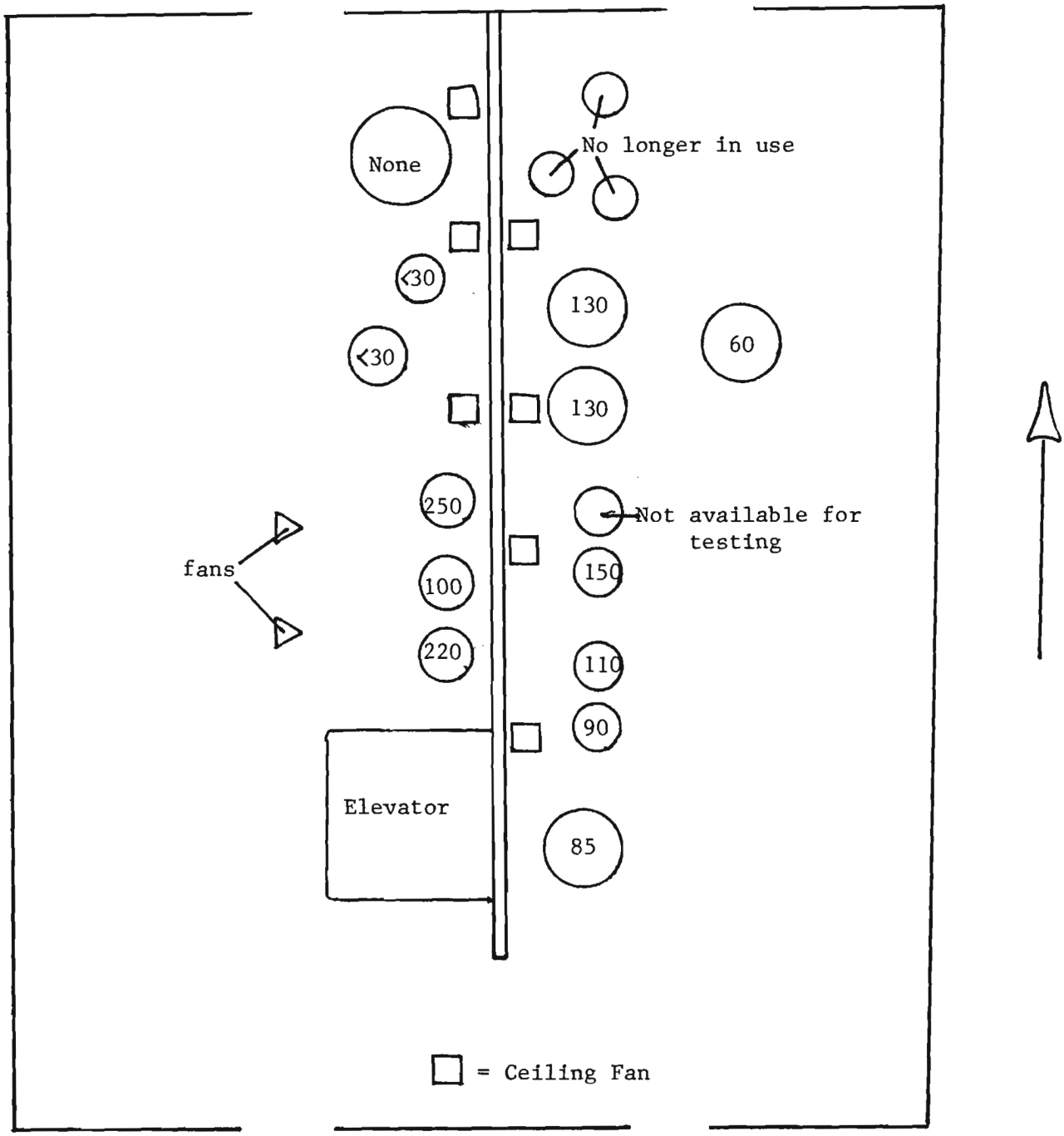
A continuous carbon monoxide monitor placed in the north end of the lower soaphouse indicated a concentration range from 25-83 ppm carbon monoxide. One lift-truck was present in the area intermittantly. Inadequate general ventilation in this area of the lower soaphouse allows concentrations of gases and vapors to build up. Further discussion of this topic is included under the heading Ventilation.

4.5 VENTILATION

4.5.1 Local Exhaust Ventilation

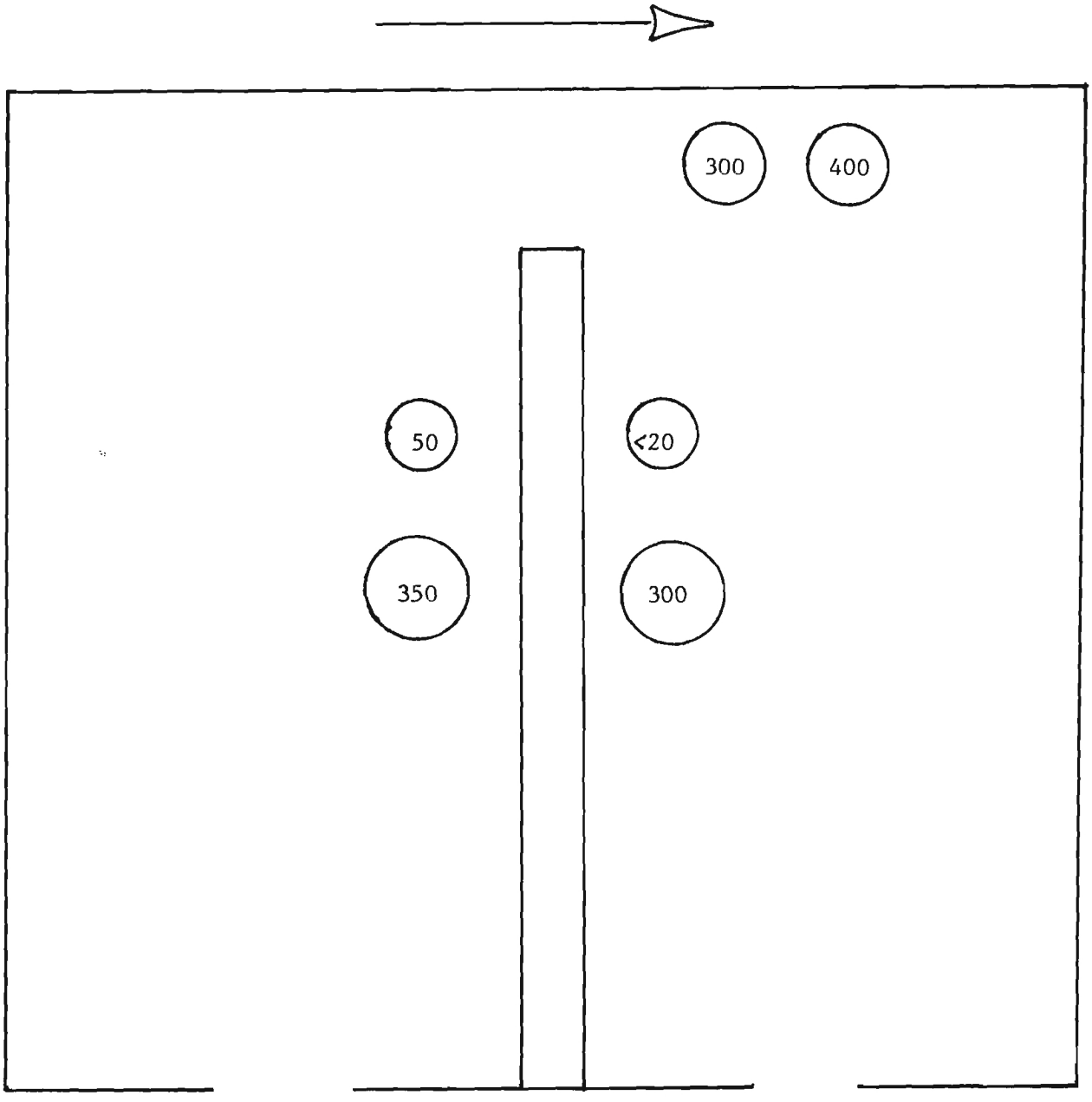
Local exhaust ventilation refers to the ventilation or exhaust of a specific operation such as a compounding vat. Measurements were taken on each compounding vat in the lower soaphouse and the flammable liquids area. The results of these measurements are shown on Figures 4.0 and 4.1. All measurements represent face velocities and are expressed in feet per minute. Although the recommended face velocity will vary depending on the toxicity of the material to be controlled, as a rule of thumb, 100 feet per minute is considered the minimum recommended face velocity.

The measurements in the lower soaphouse indicate several exhaust hoods below the 100 ft/min. face velocity. On the north side of the soaphouse, five hoods are connected into the same exhaust system. It is evident from the data that the system is out-of-balance with three hoods maintaining face velocities from



UPPER SOAPHOUSE
Ventilation Measurements
(Numbers represent exhaust face velocities in Ft/min)

Figure 4.0



FLAMMABLE LIQUIDS HOUSE
Ventilation Measurements
(Numbers represent exhaust face velocities in Ft/min)

Figure 4.1

100-250 ft/min, and the remaining two below 30 ft/min. It was noted that two floor fans in this area make the local exhaust of three hoods ineffective. These should be moved so they are not blowing directly at the exhausted compounding vats. One additional mixing vat located on the north side of the lower soaphouse is not equipped with local exhaust. This vat is only used for waxes or other compounds of low volatility according to the area supervisor.

Ventilation measurements of six vats on south side of the lower soaphouse indicated four above 100 ft/min., two slightly below 100 ft/min. and one at 60 ft/min. One vat was not available for testing and three are no longer in use. It was noticed that the hood on the vat with only 60 ft/min. was in need of repair and open on three sides. Closing the other two sides will increase the face velocity and reduce the amount of volatile materials released into the workplace air.

Local exhaust measurements were conducted on six mixing vats in the flammable liquids house. The exhaust was found to be adequate on four of the hoods. On two hoods, however, the exhaust was minimal. Ductwork should be checked for any blockages and the system balanced so that each of the four hoods (two systems) approximate 200 ft/min. (face velocity). Employees should be instructed not to alter the gates in the ductwork once it has been properly balanced.

4.5.2 General Ventilation

All the air sampling data indicate that general ventilation in the northwest corner of the lower soaphouse is inadequate. At the present time, floor fans provide the only means of air movement. Unfortunately, these fans do not remove contaminants in the air. It was noted that the highest concentrations of organic vapors and carbon monoxide gas were measured in this area of the soaphouse.

General ventilation may be supplied to this area through several ways. Ideally, air would be brought into the area through the west wall and exhausted through the east wall. However, since the west wall was originally built to support the weight of a locomotive, this would be a major task. Alternatively, air could be supplied through ducts and diffusers to this area. The exhaust ducts could connect through the east wall and straight up to the roof. Roof mounted fans would supply the necessary exhaust volume. It was noted that currently two large mixing vats are where the exhaust ducts would be placed. These two vats are no longer in use and would need to be removed or the bottoms cut-out and the ducts run through them.

General ventilation in other areas of the soaphouse and flammable liquids house appeared adequate to avoid the build-up to toxic gases and vapors, unless a major spill was involved.

Ventilation is obtained mainly through the use of wall and ceiling fans.

Stagnant air was noticed in the northeast corner of the lower soaphouse, drum filling area. Consideration should be given to installing a fan at the distal end of the pipe chase leading from this corner of the room. This would draw air out of this area.

4.6 HOUSEKEEPING AND PERSONAL PROTECTIVE EQUIPMENT

Housekeeping in the soaphose (upper and lower) and the flammable liquids house need improvement. Floor drainage is the major housekeeping problem in the lower soaphouse. This could be improved by building-up the perimeter and center areas of the drum-filling area to accelerate run-off.

Aisles in the upper and lower soaphouse are often blocked by drums and boxes. In case of fire these aisles should be kept clear at all times. Further, emergency showers and eyewashes should be accessible if needed.

The use of personal protective equipment is inconsistent. Employees appeared to be aware that gloves, aprons, safety glasses (with side shields) or goggles were required; however, this was not enforced. All employees were observed wearing boots to protect their feet.

An emergency shower and eye wash is available in the lower soaphouse. The shower needs repair. Additional eye washes are needed in the gallon fill area and the northwest corner of the lower soaphouse (old powders area). A second shower should be available in the old powders area as well. Several employes were asked if they knew where the eye wash was located. Two of the three did not know its location.

A splash guard should be installed in the gallon fill area to protect employees from chemical burns or skin absorption of hazardous materials. The guard should be a hinged plexiglass to protect against splashing when containers are overfilled.

This Report Prepared By:

William M. Ewing
Industrial Hygienist

This Report Approved By:

James L. Burson, CIH
Occupational Safety and Health
Consultation Program

APPENDIX A

Results of Sampling

Table A-1

Plant ZEP MANUFACTURING COMPANY

Atlanta, Georgia (Soaphouse and Flammable Liquids)

Materials n-Hexane (n-H), Hexane equivalent (HE), 1,2-epoxy butane (1,2-EB), 1,1,1-trichloroethane (1,1,1-T) Methylene Chloride (MeCl), Perchloroethylene (Per), Toluene, Xylene, Ethyl benzene (E Bz), p-ethyl toluene (p-ET), Trimethylbenzene (TME), C8-C10 Aromatic Hydrocarbons (C8-C10), Butyl Cellosolve (Butyl C), o-dichlorobenzene (o-Dcb), p-dichlorobenzene (p-Dcb), Isopropyl alcohol (IPA)

Date 1982	Sample Number	Description	Sampling Period		Concentrations								Concentrations							
			Start	Stop	n-H (ppm)	HE (ppm)	1,2-EB (ppm)	111-T (ppm)	MeCl (ppm)	Per (ppm)	Toluene (ppm)	Xylene (ppm)	E Bz (ppm)	p-ET (ppm)	TME (ppm)	C8-C10 (ppm)	Butyl C (ppm)	o-Dcb (ppm)	p-Dcb (ppm)	IPA (ppm)
8/18	CT-32	A. Reese, Flammable Liquids Hse. Compounder	0832	1342	0.05	4.11	—	1.01	27.5	3.10	0.93	2.56	0.25	0.51	0.52	0.93	—	0.03	0.10	—
8/18	CT-31	T. Peneley, Flammable Liquids, Lift-truck operator	0850	1342	0.05	2.49	—	0.81	5.59	1.81	0.55	2.68	0.21	0.35	0.37	0.69	—	0.05	0.06	—
8/18	CT-33	P. Green, Upper Soaphouse, Compounder	0840	1512	0.07	1.15	—	0.42	8.70	0.20	0.07	1.42	0.12	0.29	0.26	0.60	0.13	0.06	0.03	1.40
8/18	CT-35	W. Montgomery, Lower Soaphouse Dispensing liquids	0907	1502	0.04	1.96	0.30	1.43	17.5	1.75	0.82	7.93	0.70	2.52	2.26	3.74	0.82	0.48	0.17	12.1
8/19	CT-38	Area sample, lower soaphouse, northwest corner	0942	1347	0.06	18.3	0.93	51.7	37.4	25.5	2.10	11.4	0.95	1.62	1.12	3.28	1.95	0.05	3.01	—
		OSHA Permissible Exposure Limit			500	—	—	350	500	100	200	100	100	—	—	—	50	50	75	400
		NIOSH Recommended PEL			100	—	—	350	75	50	100	100	—	—	—	—	—	—	—	400
		ACGIH Threshold Limit Value			100	—	—	350	100	100	100	100	100	—	25	—	25	50	75	500

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INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Company
Atlanta, Georgia (Soaphouse)

Materials Formaldehyde (HCHO)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			HCHO (mg/m^3)	HCHO (ppm)
8/18	HCHO-1	W. Montgomery, Lower Soaphouse, Filling 4 drums with "Big John"	0916	0931	15	15	1.17	0.96
8/18	HCHO-2	Area Sample, On Top of 4 Drums Filled With "Big John"	0916	0931	15	15	3.21	2.62
8/18	HCHO-3	T. Byrd, Upper Soaphouse, Mixing "Big John" (474 gals. HCHO used)	1031	1052	21	21	2.35	1.91
8/18	HCHO-4	Area Sample, 4 ft. South of Mixing Vat in Upper Soaphouse	1032	1052	20	20	2.48	2.02
		OSHA 8-hour, TWA limit					-	3.0
		OSHA 30 min. ceiling limit					-	5.0
		OSHA peak conc. limit					-	10.0
		NIOSH recommended limit (30 min)					1.2	0.8
		ACGIH TLV, 8-hour TWA and ceiling					3.0	2.0
		ACGIH TLV, 8-hour TWA (intended change for 1982)					Lowest Possible	

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INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Company
Atlanta, Georgia (Soaphouse)

Materials Carbon Monoxide (CO)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			CO (ppm)	
8/18	CO-10	W. Gardner, Lift-Truck Operator Upper Soaphouse	0842	1512	7.8	390	9.6	
8/18	CO-20	L. Reid, Lift-Truck Operator Lower Soaphouse	0911	1501	7.0	350	24.	

RESULTS OF SAMPLE ANALYSES

OF

BULK INSULATION SAMPLES

Sample Description	Analytical Results
S-2, ID #1482 lagging of DEA storage tank, upper liquids	10% chrysotile asbestos 90% mineral wool
S-3, ID #1483 lagging of bulk gasoline storage tank, upper liquids	10% chrysotile asbestos 90% mineral wool

Samples analyzed by polarized-light microscopy with dispersion staining.

APPENDIX B

Sampling and Analytical Methods

CARBON MONOXIDE

Sampling for carbon monoxide (CO) was conducted by using the following two techniques.

Short-term area sampling (direct reading instantaneous) was performed either by drawing measured volumes of air through a length of stain detector tube via a hand-operated sampling pump, or by a direct-reading meter.

In the detector tube system, the CO indication is based upon the reduction of potassium palladosulfite impregnated silica gel giving a color change of yellow to brown in the presence of CO. The length of stain of the detector chemical is proportional to the CO concentration (in ppm) and must be matched to a chart corresponding to the number of pump strokes employed (1 full stroke = 100 cc) on the instruction sheet which accompanies the tubes.

The basic principle of operation of the direct reading meter involves drawing air (pre-cleansed to remove interferences) through an electrochemical sensor cell at a nominal flowrate of 700 cc/minute. The sensor cell is composed of a catalytically active sensing electrode (platinum), a counter electrode, a reference electrode and an aqueous sulfuric acid solution as the electrolyte. In the direct reading meter, the electrochemical process is carried out at a potential-controlled electrode. The current measured upon introduction of CO to the sensor cell is the result of the electro-oxidation of CO to carbon dioxide (CO_2) and is proportional to the partial pressure of CO in the sampled air.

FORMALDEHYDE

Integrated long-term samples were collected by drawing air at measured flowrates (nominal 1 liter per minute) through all glass midget impingers containing 15 ml of 1% sodium bisulfite absorbing solution using battery-powered, portable pumps. After collection, the impinger solutions were immediately transferred into glass bottles and sealed with teflon lined caps for transport to the laboratory.

Laboratory analysis was accomplished by treating aliquots of each sample with aqueous chromotropic acid and concentrated sulfuric acid to form a colored complex whose absorbance was measured using a spectrophotometer. The absorbances of the samples were compared to the absorbances of aqueous standards prepared from sodium formaldehyde bisulfite and carried through the same analytical procedure. Results of the analysis in conjunction with sampling data were used to calculate the concentrations of airborne formaldehyde (expressed in ppm) and include any necessary corrections for blank and recovery determinations run in parallel with the analysis.

ORGANIC VAPORS

Samples were collected by using battery-powered, portable pumps to draw air at measured flowrates through:

1. Charcoal Sample Collection Tubes, containing 450-milligram (front) and 150-milligram (back) sections of activated charcoal, or

2. Charcoal Tubes containing 100-milligrams (front) and 50-milligram (back) sections of activated charcoal.

Immediately after sampling, the ends of tubes were sealed with polyethylene caps for transport to the laboratory, where they were refrigerated until analysis.

In the laboratory, front and back sections of each tube were desorbed separately in appropriate volumes of carbon disulfide, and aliquots of the resultant solutions injected into a gas chromatograph. Quantites of each analyte present were determined by comparison of areas under the sample chromatogram peaks with areas under chromatogram peaks for standards prepared in carbon disulfide. Analytical results, which include any necessary corrections for parallel blank and recovery determinations, were used in conjunction with sampling data (volume of air sampled) to calculate the concentrations of airborne analytes represented by each sample, expressed in parts analyte per million parts of air, by volume (ppm).

APPENDIX C

Toxicological Information

ASBESTOS

Asbestos is a generic term referring to various fibrous mineral silicates, including chrysotile (hydrated magnesium silicate), amosite (iron-magnesium silicate), crocidolite (sodium-iron silicate), tremolite (calcium-magnesium silicate), anthophyllite (another iron-magnesium silicate), and actinolite (calcium-magnesium-iron silicate).

The potential health hazard associated with exposure to asbestos results from inhalation of airborne fibers; small asbestos fibers can pass readily through the upper respiratory tract and be deposited in the terminal bronchioles of the lung. There they can produce a local irritation which the body attempts to overcome by initiating a tissue response resulting in the encapsulation of the fibers and consequent formation of "asbestos bodies". Asbestos fibers are the causative agents in cases of asbestosis, a progressive disease characterized by diffuse interstitial fibrosis and, at times, pleural changes of fibrosis and calcification. It is often evident by such clinical signs as rales and dyspnea. In its severe form, asbestosis can contribute to, and result in, death due to the inability of the body to obtain oxygen or the heart to pump blood through the scarred lungs.

Exposure to airborne asbestos fiber also has been associated with bronchogenic carcinoma (a malignancy of the interior of the lung), mesothelioma (a diffuse malignancy of the lining of the chest or abdomen), and cancer of the stomach, colon, and rectum. Cigarette smoking can enhance the incidence of bronchogenic carcinoma from this substance.

In order to protect workers from such occupational hazards, the Occupational Safety and Health Administration (OSHA) has established a limit of two fibers (longer than five micrometers) per cubic centimeter of air as an eight-hour, time weighted average (TWA) concentration limit. This OSHA standard also specifies a ceiling (peak) exposure limit of ten fibers per cubic centimeter of air. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value of five fibers (longer than five micrometers) per cubic centimeter of air. The National Institute of Occupational Safety and Health (NIOSH) has recommended a daily TWA exposure limit of 0.1 fiber per cubic centimeter of air, with a peak concentration limit of 0.5 fibers per cubic centimeter bases on a 15 minute sample period.

BUTYL CELLOSOLVE

Butyl cellosolve ($C_4H_9OCH_2CH_2OH$), ethylene glycol monobutyl ether, 2-butoxyethanol) is a colorless liquid with a slightly rancid odor.

It can be absorbed via inhalation of vapor and percutaneous absorption of liquid. It penetrates the skin readily and toxic action from excessive skin exposure may in some instances, be more likely than from vapor inhalation. However, in most industrial settings, vapor inhalation is the most significant route of exposure.

Acute exposure to butyl cellosolve results in narcosis, pulmonary edema, and severe kidney and liver damage. Symptoms from repeated overexposure to vapors are fatigue and lethargy, headache, nausea, anorexia, and tremor. Rats show increased hemolysis of erythrocytes from inhalation of butyl cellosolve.

Butyl cellosolve is irritating to the skin and mucous membrances. Vapor exposure may cause conjunctivitis and upper respiratory tract irritation. Temporary corneal clouding may also result and may last several hours. Exposures to 100 ppm result in eye, nose, and throat irritation in some persons. Acute intoxication in animals causes death, if early, due to narcosis, and if delayed for several days, to pneumonitis and kidney injury.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 50 ppm as a standard for occupational exposure. ACGIH currently lists as "tentative" a short-term exposure limit (up to 15 minutes) of 150 ppm. This value carries the "skin" notation, warning of the potential for percutaneous absorption; this specific concentration limit is based on the presumption that there is no concurrent exposure via the skin absorption and oral ingestion routes.

FORMALDEHYDE

Formaldehyde (HCHO) is a colorless gas at ordinary temperatures, with a pungent odor which is perceptible at concentrations even lower than one ppm. Its characteristic odor and its strong irritating effect upon the eyes and upper respiratory passages may provide some warning of the presence of appreciable concentrations of airborne formaldehyde.

Formaldehyde is toxic by ingestion and inhalation and it may also cause skin lesions. It is primarily an irritant of the skin, eyes and mucous membranes of the upper and lower respiratory tract. A concentration of two to three ppm causes slight irritation of the eyes, nose and pharynx; at four to five ppm, discomfort rapidly increases, ten ppm is tolerated with difficulty even briefly; between ten and twenty ppm, there is severe difficulty in breathing, burning of the eyes, nose and trachea, intense lachrymation and severe cough. Asthmatic symptoms may occur due to allergic sensitivity to formaldehyde even at low concentrations.

A recent report of an ongoing study by the Chemical Industry Institute of Toxicology indicates that formaldehyde may be linked to nasal carcinoma in rats.

There have been reports of both inflammatory and allergic dermatitis due to direct contact with solutions, solids or resins containing free formaldehyde. The allergic form is usually the result of allergic sensitization, and may follow contact with only very small quantities.

Accidental ingestion of formalin (37% formaldehyde solution) causes prompt, severe irritation of the gastrointestinal tract. Circulatory collapse, central nervous system and kidney damage have been observed.

The Occupational Safety and Health Administration (OSHA) has adopted the American National Standards Institute (ANSI) Z37.16-1967 Standard for Exposure to Formaldehyde, which established an eight-hour, time-weighted average concentration limit of three ppm, along with an acceptable ceiling concentration of five ppm, not to be exceeded for longer than 30 minutes in an eight-hour shift, and a maximum peak concentration of ten ppm, not to be exceeded at any time. To prevent irritation in all exposed individuals, the American Conference of Governmental Industrial Hygienists (ACGIH) has recommended a ceiling limit of two ppms, not to be exceeded at any time. The National Institute for Occupational Safety and Health (NIOSH) has recommended a ceiling concentration limit of one ppm for any 30 minute sampling period.

HEXANE

Hexane (n-hexane, $CH_3(CH_2)_4CH_3$) is a colorless, volatile liquid and is highly flammable.

Asphyxia may be produced by exposure to high concentrations of hexane. Acute exposure may cause narcosis resulting in slight nausea, headache and dizziness. Myocardial sensitization to epinephrine may occur but is of low order. Peripheral neuropathy has been reported resulting from exposure to hexane.

Dermatitis and irritation of mucous membranes of the upper respiratory tract can be produced.

Hexane is thrice as toxic as is pentane; concentrations of 30,000 ppm produced narcosis in mice within 30 to 60 minutes; convulsions and death at 35,000 to 40,000 ppm. In man, an exposure to 2,000 ppm for ten minutes resulted in no effects, but 5,000 ppm resulted in dizziness and a sensation of giddiness. Unacclimatized individuals found no irritation at 500 ppm but encountered nausea, headache, eye and throat irritation at 1,400 to 1,500 ppm. Narcotic symptoms have been observed frequently when concentrations exceeded 1,000 ppm, but not from levels below 500 ppm.

To prevent the central nervous system effects, the Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted-average (TWA) concentration limit of 500 ppm as a standard for occupational exposure. The American Conference of Governmental Industrial Hygienists (ACGIH) has established an eight-hour, TWA threshold limit value (TLV) of 100 ppm and a short-term (up to 15 minutes) exposure limit of 125 ppm.

ISOPROPYL ALCOHOL

Isopropyl alcohol (isopropanol, $(CH_3)_2CHOH$) is a colorless, volatile liquid with an odor resembling that of ethyl alcohol.

The main effect from inhalation is narcosis. Isopropyl alcohol is more narcotic and toxic than is ethyl alcohol, but less so than n-propyl alcohol. A slight tolerance to narcosis may be acquired. There is little or no accumulation of isopropyl alcohol in the body. Ingestion of isopropyl alcohol can produce an action on the central nervous system similar to that of other alcohols, causing drowsiness, headache of varying intensity, narcosis, and in severe cases, coma with or without shock.

Animals manifested irritation of the mucous membranes, ataxia, prostration, deep narcosis, and death from high concentrations of isopropyl alcohol.

In general, isopropyl alcohol is not a strong dermal irritant. However, it is possible that some individuals may develop contact dermatitis or become allergic to it. Mild irritation of the eyes, nose, and throat occurs in humans exposed to 400 ppm in air.

Based on recent reports, an isopropyl alcohol production process (strong-acid process) can be considered to present a cancer hazard, but there is no evidence that isopropyl alcohol itself is the carcinogen.

This material is a flammable liquid and could present a fire hazard.

The Occupational Safety and Health Administration (OSHA) has established a standard of 400 ppm in air as an eight-hour, time-weighted average concentration limit. To prevent narcosis, the American Conference of Governmental Industrial Hygienists (ACGIH) recommends an eight-hour, time-weighted average threshold limit value of 400 ppm and a short-term (up to 15 minutes) exposure limit of 500 ppm. The National Institute for Occupational Safety and Health (NIOSH) recommends a time-weighted average exposure limit of 400 ppm up to a ten hour workday with a ceiling of 800 ppm by a sampling time of 15 minutes.

METHYLENE CHLORIDE

Methylene chloride (dichloromethane, CH_2Cl_2) is a colorless liquid with a sickly, sweet odor detectable at concentrations above 225 ppm. This odor cannot be considered a good warning because humans readily adapt to it.

In strong untraviolet light, or in contact with open flames or hot surfaces, or both, methylene chloride, in the presence of air and moisture, is decomposed with the formation of hydrogen chloride, carbon dioxide, carbon monoxide, and possibly the toxic gas phosgene. Therefore, welding which produces UV light should not be done near areas in which methylene chloride vapor may be present.

The toxicities of carbon monoxide and methylene chloride are similar. Methylene chloride is metabolized to carbon monoxide in the body. Therefore, the carboxyhemoglobin concentration in blood is a function of the methylene chloride absorbed either through the skin or the lungs. Like carbon monoxide, the most important biological effects of methylene chloride are the significant interference with delivery of oxygen to tissues and abnormalities in the central nervous system's function. Complaints commonly reported by workers using this material include chest pains, heart palpitations, rapid pulse, shortness of breath, dyspnea, tingling in the hands and feet, muscular pains in the arms and legs, headache, and increased fatigue.

Methylene chloride is mildly irritating to the skin on repeated contact. Liquid methylene chloride splashed in the eyes will be painful and irritating, but it is not likely to cause serious injury. Methylene chloride can be absorbed through the skin.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends an eight-hour, time-weighted average (TWA) threshold limit value of 100 ppm in air with a short-term exposure limit of 500 ppm for a period up to 15 minutes. The Occupational Safety and Health Administration (OSHA) has adopted the American National Standards Institute (ANSI) standard (Z37.3-1969) which established an eight-hour, TWA concentration limit of 500 ppm, along with an acceptable ceiling concentration of 1,000 ppm, not to be exceeded for longer than five minutes in any two hours, and a maximum peak concentration of 2,000 ppm, not to be exceeded at any time. The National Institute for Occupational Safety and Health (NIOSH) has recommended a standard of 75 ppm as a TWA for up to a 10-hour workday, in the absence of occupational exposure to carbon monoxide. In the presence of exposure to carbon monoxide in excess of 9 ppm TWA, the combined concentrations of carbon monoxide and methylene chloride must be considered. NIOSH has recommended a ceiling concentration of 500 ppm as determined by a 15 minute sampling period. The current OSHA PEL is 500 ppm for an eight-hour, time-weighted average exposure.

PERCHLOROETHYLENE

Perchloroethylene (1,1,2,2-tetrachloroethylene) is a colorless solvent with an odor like ether or chloroform. Human exposure to high concentrations of the vapor in air may result in maladies of the liver, kidneys, eyes, upper respiratory system, and the central nervous system. Skin contact with liquid perchloroethylene may result in skin burns, blistering, erythema. Skin effects due to chronic perchloroethylene exposure (in air) may result in eczema.

Symptoms of exposure to perchloroethylene vapors vary depending on the concentration. At relatively low concentrations (75-100 ppm) one may experience lightheadedness, slight eye irritation, throat irritation, and frontal headache. At higher concentrations symptoms of fatigue, vertigo, nausea, and vomiting may become apparent. Prolonged exposure to high concentrations may lead to liver dysfunction, pulmonary edema, kidney failure, neurological disorders, coma, and eventually death.

The current Occupational Safety and Health Administration Permissible Exposure Limit for perchloroethylene is 100 ppm based on a 8-hour, time-weighted average (TWA). The National Institute for Occupational Safety and Health's recommended standard is 50 ppm based on a 10-hour, TWA.

TOLUENE

Toluene (toluol, methyl benzene) is a clear, colorless, non-corrosive liquid with a sweet, pungent odor. Toluene is readily absorbed from the lungs, the gastrointestinal tract, and to a small extent, through the intact skin. Part of the absorbed toluene is eliminated in the expired air, but a large percentage is excreted in the urine. The only industrial hazards of significance result from inhalation of excessive concentrations of vapor, prolonged skin contact with the liquid, and liquid contamination of the eyes.

With acute exposure, toluene acts predominantly upon the central nervous system as a depressant causing fatigue, headache, confusion, paresthesia, dizziness, and muscular incoordination. There is usually some delay in the development of symptoms, and hence the effects commonly appear at the end of the work shift. With sustained exposure to high concentrations, death may ensue from paralysis of the respiratory centers.

Continuous daily exposures to low concentrations of toluene vapors may give rise to a clinical picture of chronic intoxication. Such cases may show varying degrees of fatigue, general nervousness, insomnia, and loss of appetite and weight. Frequent and sustained skin contact with liquid toluene may result in the development of dermatitis because of the defatting properties of toluene as well as its local irritative action. Toluene does not cause the severe injury to the bone marrow characteristic of benzene.

The Occupational Safety and Health Administration has adopted the ANSI Z37.12-1967 Standard for Exposure to toluene, which established an eight-hour, time-weighted average of 200 ppm with a ceiling of 300 ppm and an acceptable peak exposure of 500 ppm for a duration of not more than ten minutes if encountered not more than once during an eight-hour workday. The American Conference of Governmental Industrial Hygienists has established a threshold limit value of 100 ppm as an eight-hour, time-weighted average. The National Institute for Occupational Safety and Health recommends an eight-hour, time-weighted average of 100 ppm with a ceiling of 200 ppm as determined by a sampling time of ten minutes. The American National Standards Institute, Inc. revised the ANSI Z37.12-1967 in 1974. It has established a new acceptable eight-hour, time-weighted average maximum for peaks above the acceptable ceiling concentration of 500 ppm for a duration of not more than 10 minutes if encountered not more than once a day.

1,1,1-TRICHLOROETHANE

1,1,1-trichloroethane (methyl chloroform, CH_3CCl_3) is a colorless, nonflammable liquid with an odor similar to chloroform. Upon contact with hot metal or exposure to ultraviolet radiation, it will decompose to form the irritant gases hydrochloric acid, phosgene, and dischloroacetylene.

It acts as a narcotic and depresses the central nervous system. Acute exposure symptoms include dizziness, drowsiness, increased reaction time, unconsciousness, and death. Impairment of the central nervous system, to the extent that escape would be impossible, has occurred experimentally in human subjects when the exposure concentration of 1,1,1-trichloroethane was increased from zero to 2,650 ppm during 15 minutes. Impaired coordination and balance have also been demonstrated in experimental exposures of human subjects to 1,1,1-trichloroethane at 900-1,000 ppm for 20 minutes or more.

Liquid and vapor are irritating to eyes on contact. This effect is usually noted first in acute exposure cases. Mild conjunctivitis may develop but recovery is usually rapid. Repeated skin contact may produce a dry, scaly, and fissured dermatitis, due to the solvent's defatting properties.

Animals exposed repeatedly to high concentrations exhibited some reversible changes in liver, but they were not severe effects associated with carbon tetrachloride. Chronic exposure to 1,000 ppm resulted in moderate fatty degeneration of the liver but no liver necrosis or kidney injury.

1,1,1-trichloroethane has been shown to have a direct effect on the cardiovascular system. Depression of the circulatory system was found, evidenced by a drop in blood pressure.

To prevent odor, mild irritation and the possible effects of prolonged undue exposure, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 350 ppm as a standard for occupational exposures. ACGIH has also recommended a short-term exposure limit of 450 ppm (up to 15 minutes). The National Institute for Occupational Safety and Health (NIOSH) has recommended a ceiling concentration of 350 ppm as determined by a 15 minute sample.

XYLENE

Xylene (xylol, dimethyl benzene) is a clear colorless, flammable liquid having an aromatic odor similar to that of benzene and toluene. There are three isomers, ortho (1,2-dimethyl benzene), meta (1,3-dimethyl benzene), and para (1,4-dimethyl benzene). Commercial xylene is a mixture of the three forms with meta being the major component.

Inhalation is the primary exposure route for absorption of xylene. Although xylene can be absorbed through the skin, this is not a significant factor in industrial exposures.

Acute exposures to high concentrations result in a narcotic effect on the central nervous system which can lead to unconsciousness. Characteristic indications of acute exposure include giddiness, fatigue, palpitation, dyspnea, anxiety, and numbness of hands and feet.

Effects of chronic exposure to xylene are headache, fatigue, lassitude, irritability, and in some cases, digestive disturbances, but xylene does not produce the severe hematological changes characteristic of chronic benzene poisoning. Higher concentrations or longer exposure periods can cause eye and respiratory tract irritation, and the beginning of narcotic effects which may limit self-rescue ability. The defatting action on the skin can lead to severe dermatitis following repeated or prolonged contact.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average concentration limit of 100 ppm as a standard for occupational exposure. ACGIH currently lists as "tentative" short-term exposure limit (up to 15 minutes) of 150 ppm. The National Institute for Occupational Safety and Health (NIOSH) recommends a time-weighted average exposure of 100 ppm for up to a 10-hour workday, 40-hour workweek, with a ceiling concentration of 200 ppm as determined by a sampling period of 10 minutes.

APPENDIX D

OSHA and EPA Asbestos Standards

OSHA

1910.1001 - ASBESTOS

(a) **Definitions**

For the purpose of this section.

(1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) PERMISSIBLE EXPOSURE TO AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS

(1) Standard effective July 7, 1972. The 8-hour, time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) Standard effective July 1, 1976. The 8-hour, time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) Ceiling concentration. No employee shall be exposed at any time to airborne concentration of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimer of air, as determined by the method prescribed in paragraph (e) of this section.

(c) METHODS OF COMPLIANCE

(1) ENGINEERING METHODS

(i) Engineering controls. Engineering controls, such as but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) LOCAL EXHAUST VENTILATION

(a) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See Section 1910.6 concerning the availability of ANSI-A9.2-1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in Section 1910.100.

(iii) PARTICULAR TOOLS

All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) WORK PRACTICES

(i) Wet methods. Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) Particular products and operations. No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) Spraying, demolition, or removal. Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d) (2) (iii) of this section and with special clothing in accordance with paragraph (d) (3) of this section.

(d) PERSONAL PROTECTIVE EQUIPMENT

(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivision (i) and (ii), or (iii) of this subparagraph, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health Department, of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 P.R. 6244, March 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) Air purifying respirators. A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) Powered air purifying respirators. A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) Type "C" supplied-air respirators, continuous flow or pressure-demand class. A type "C" continuous flow or pressure-demand, supplied air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) ESTABLISHMENT OF A RESPIRATOR PROGRAM

(a) The employer shall establish a respirator program in accordance with the requirements of the American National Standard Practices for respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.

(b) See Section 1910.6 concerning the availability of ANSI Z88.2-1969 and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in Section 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of the respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special Clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms:

(i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering:

(a) Laundering of asbestos-contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(b) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in (a) of this subdivision to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) METHOD OF MEASUREMENT

All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400-450 x (magnification) (4 millimeter objective) with phase contrast illumination.

(f) MONITORING

(1) Initial determinations. Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitoried in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) Personal Monitoring

(i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour, time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) Environmental monitoring

(i) Samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour, time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) Employee observation of monitoring. Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) CAUTION SIGNS AND LABELS

(1) Caution Signs

(i) Posting. Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) Sign specifications. The warning signs required by subdivision (i) of this subparagraph shall conform to the requirements of 20" x 14" vertical format signs specified in Section 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

LEGEND

	NOTATION
Asbestos	1" Sans Serif, Gothic or Block
Dust Hazard	3/4" Sans Serif, Gothic or Block
Avoid Breathing Dust	1/4" Gothic
Wear Assigned Protective Equipment	1/4" Gothic
Do Not Remain in Area Unless Your Work Requires It	1/4" Gothic
Breathing Asbestos Dust May be Hazardous to Your Health	14 Point Gothic

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) Caution Labels

(i) Labeling. Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) Label specifications. The caution labels required by subdivision (i) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION
Contains Asbestos Fibers
Avoid creating Dust
Breathing Asbestos Dust May Cause
Serious Bodily Harm

(h) HOUSEKEEPING

(1) Cleaning. All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) Waste disposal. Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) Recordkeeping

(1) Exposure records. Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 20 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either.

(2) Employee access. Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) Employee notification. Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) MEDICAL EXAMINATIONS

(1) General. The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) Preplacement. The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(3) Annual examinations. On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(4) Termination of employment. The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(5) Recent examinations. No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) Medical records.

(i) Maintenance. Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be retained by employers for at least 20 years.

(ii) Access. Records of the medical examinations required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20(a)-(e) and (g)-(i). These records shall also be provided upon the request to the Director of NIOSH. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

t B—National Emission Standard for Asbestos

Applicability.

rovisions of this subpart are ap- to those sources specified in

Definitions.

; used in this subpart are defined :t, in subpart A of this part, or in ion as follows:

Asbestos" means actinolite, amo- hophyllite, chrysotile, crocidolite, e.

Asbestos material" means as- r any material containing as-

Particulate asbestos material" nely divided particles of asbestos l.

Asbestos tailings" means any ste product of asbestos mining or operations which contains as-

Outside air" means the air out- dings and structures.

Visible emissions" means any s which are visually detectable the aid of instruments and which particulate asbestos material.

Asbestos mill" means any facility in the conversion or any inter- step in the conversion of asbestos commercial asbestos. Outside of asbestos materials is not con- part of such facility.

Commercial asbestos" means any of asbestos which is produced by g asbestos from asbestos ore.

Manufacturing" means the com- f commercial asbestos, or in the roven friction products the com- f textiles containing commercial with any other material(s), in- commercial asbestos, and the g of this combination into a as specified in § 61.22(c).

Demolition" means the wrecking g out of any load-supporting al member and any related re- or stripping of friable asbestos s.

Friable asbestos material" means erial that contains more than 1 asbestos by weight and that can bled, pulverized, or reduced to when dry, by hand pressure.

Control device asbestos waste" any asbestos-containing waste that is collected in a pollution levice.

Renovation" means the remov- tripping of friable asbestos ma- used on any pipe, duct, boiler, eactor, turbine, furnace, or al member. Operations in load-supporting structural s are wrecked or taken out are d.

h (m) revised by 43 FR 26373, June]

Planned renovation" means a on operation, or a number of erations, in which the amount e asbestos material that will be or stripped within a given pe- ime can be predicted. Operations individually non-scheduled are included, provided a number of such operations can be predicted to occur during a given period of time based on operating experience.

(o) "Emergency renovation" means a renovation operation that results from a sudden, unexpected event, and is not a planned renovation. Operations necessitated by non-routine failures of equipment are included.

(p) "Adequately wetted" means sufficiently mixed or coated with water or an aqueous solution to prevent dust emissions.

(q) "Removing" means taking out friable asbestos materials used on any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member from any building, structure, facility, or installation.

(r) "Stripping" means taking off friable asbestos materials from any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member.

[Paragraph (q) and (r) revised by 43 FR 26373, June 19, 1978]

(s) "Fabricating" means any processing of a manufactured product containing commercial asbestos, with the exception of processing at temporary sites for the construction or restoration of buildings, structures, facilities or installations.

(t) "Inactive waste disposal site" means any disposal site or portion thereof where additional asbestos-containing waste material will not be deposited and where the surface is not disturbed by vehicular traffic.

(u) "Active waste disposal site" means any disposal site other than an inactive site.

(v) "Roadways" means surfaces on which motor vehicles travel including, but not limited to, highways, roads, streets, parking areas, and driveways.

(w) "Asbestos-containing waste material" means any waste which contains commercial asbestos and is generated by a source subject to the provisions of this subpart, including asbestos mill tailings, control device asbestos waste, friable asbestos waste material, and bags or containers that previously contained commercial asbestos.

[40 FR 48292, October 14, 1975]

(x) "Structural member" means any load-supporting member, such as beams and load-supporting walls; or any non-load-supporting member, such as ceilings and non-load-supporting walls.

[42 FR 12127, March 2, 1977]

61.22 Emission standard.

(a) Asbestos mills: There shall be no visible emissions to the outside air from any asbestos mill except as provided in paragraph (f) of this section.

[39 FR 15936, May 3, 1974]

(b) Roadways: The surfacing of roadways with asbestos tailings or with asbestos-containing waste that is generated by any source subject to paragraphs (c), (d), (e) or (h), of this section is prohibited, except for temporary roadways on an area of asbestos ore deposits. The deposition of asbestos tailings or asbestos-containing waste on roadways covered with snow or ice is considered "surfacing."

(c) Manufacturing: There shall be no visible emissions to the outside air, except as provided in paragraph (f) of this section, from any of the following operations if they use commercial asbestos or from any building or structure in which such operations are conducted.

[40 FR 48292, October 14, 1975]

(1) The manufacture of cloth, cord, wicks, tubing, tape, twine, rope, thread, yarn, roving, lap, or other textile materials.

(2) The manufacture of cement products.

(3) The manufacture of fireproofing and insulating materials.

(4) The manufacture of friction products.

(5) The manufacture of paper, millboard, and felt.

(6) The manufacture of floor tile.

(7) The manufacture of paints, coatings, caulks, adhesives, sealants.

(8) The manufacture of plastics and rubber materials.

(9) The manufacture of chlorine.

(10) The manufacture of shotgun shells.

(11) The manufacture of asphalt concrete.

(d) *Demolition and renovation.* The requirements of this paragraph shall apply to any owner or operator of a demolition or renovation operation who intends to demolish any institutional, commercial, or industrial building (including apartment buildings having more than four dwelling units), structure, facility, installation, or portion thereof which contains any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member that is covered or coated with friable asbestos materials, except as provided in paragraph (d)(1) of this section; or who intends to renovate any institutional, commercial, or industrial building, structure, facility, installation, or portion thereof where more than 80 meters (ca. 260 feet) of pipe covered or coated with friable asbestos materials are stripped or removed, or more than 15 square meters, (ca. 160 square feet) of friable asbestos materials used to cover or coat any duct, boiler, tank, reactor, turbine, furnace, or structural member are stripped or removed.

(1) (i) The owner or operator of a demolition operation is exempted from the requirements of this paragraph: *Provided,* (A) The amount of friable asbestos materials in the building or portion thereof to be demolished is less than 80 meters (ca. 260 feet) used on pipes, and less than 15 square meters (ca. 160 square feet) used on any duct, boiler, tank, reactor, turbine, furnace, or structural member, and (B) the notification requirements of paragraph (d)(1)(ii) are met.

(ii) Written notification shall be postmarked or delivered to the Administrator at least 20 days prior to com-

mencement of demolition and shall include the information required by paragraph (d)(2) of this section, with the exception of the information required by paragraphs (d)(2)(iii), (vi), (vii), (viii), and (ix) of this section, and shall state the measured or estimated amount of friable asbestos materials which is present. Techniques of estimation shall be explained.

[Paragraph (d) revised by 43 FR 26374, June 19, 1978]

(2) Written notice of intention to demolish or renovate shall be provided to the Administrator by the owner or operator of the demolition or renovation operation. Such notice shall be postmarked or delivered to the Administrator at least 20 days prior to commencement of demolition, or as early as possible prior to commencement of emergency demolition subject to paragraph (d)(6) of this section, and as early as possible prior to commencement of renovation. Such notice shall include the following information:

(i) Name of owner or operator.

(ii) Address of owner or operator.

(iii) Description of the building, structure, facility, or installation to be demolished or renovated, including the size, age, and prior use of the structure, and the approximate amount of friable asbestos materials present.

[Paragraph (iii) revised by 43 FR 26374, June 19, 1978]

(iv) Address or location of the building, structure, facility, or installation.

(v) Scheduled starting and completion dates of demolition or renovation.

(vi) Nature of planned demolition or renovation and method(s) to be employed.

(vii) Procedures to be employed to meet the requirements of this paragraph and paragraph (j) of this section.

(viii) The name and address or location of the waste disposal site where the friable asbestos waste will be deposited.

(ix) Name, title, and authority of the State or local governmental representative who has ordered a demolition which is subject to paragraph (d)(6) of this section.

(3)(i) For purposes of determining whether a planned renovating operation constitutes a renovation within the meaning of this paragraph, the amount of friable asbestos material to be removed or stripped shall be:

(A) For planned renovating operations involving individually non-scheduled operations, the additive amount of friable asbestos material that can be predicted will be removed or stripped at a source over the maximum period of time for which a prediction can be made. The period shall be not less than 30 days and not longer than one year.

(B) For each planned renovating operation not covered by paragraph (d)(3)(i)(A), the total amount of friable asbestos material that can be predicted will be removed or stripped at a source.

(ii) For purposes of determining whether an emergency renovating operation constitutes a renovation within the meaning of this paragraph, the amount of friable asbestos material to be removed or stripped shall be the total amount of friable asbestos material that will be removed or stripped as a result of the sudden, unexpected event that necessitated the renovation.

(4) The following procedures shall be used to prevent emissions of particulate asbestos material to outside air:

(i) Friable asbestos materials, used on any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member, shall be removed from any building, structure, facility or installation subject to this paragraph. Such removal shall occur before wrecking or dismantling of any portion of such building, structure, facility, or installation that would break up the friable asbestos materials and before wrecking or dismantling of any other portion of such building, structure, facility, or installation, that would preclude access to such materials for subsequent removal. Removal of friable asbestos materials used on any pipe, duct, or structural member which are encased in concrete or other similar structural material is not required prior to demolition, but such materials shall be adequately wetted whenever exposed during demolition.

(ii) Friable asbestos materials used on pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members shall be adequately wetted during stripping, except as provided in paragraphs (d)(4)(iv), (d)(4)(vi), or (d)(vii) of this section.

(iii) Pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members that are covered or coated with friable asbestos materials may be taken out of any building, structure, facility, or installation subject to this paragraph as units or in sections provided the friable asbestos materials exposed during cutting or disjoining are adequately wetted during the cutting or disjoining operation. Such units shall not be dropped or thrown to the ground, but shall be carefully lowered to ground level.

(iv) The stripping of friable asbestos materials used on any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member that has been removed as a unit or in sections as provided in paragraph (d)(4)(iii) of this section shall be performed in accordance with paragraph (d)(4)(ii) of this section. Rather than comply with the wetting requirement, a local exhaust ventilation and collection system may be used to prevent emissions to the outside air. Such local exhaust ventilation systems shall be designed and operated to capture the asbestos particulate matter produced by the stripping of friable asbestos materials. There shall be no visible emissions to the outside air from such local exhaust ventilation and collection systems except as provided in paragraph (f) of this section.

[4(i)–(iv) revised by 43 FR 26374, June 19, 1978]

(v) All friable asbestos materials that have been removed or stripped shall be adequately wetted to ensure that such materials remain wet during all remaining stages of demolition or renovation and related handling operations. Such materials shall not be dropped or thrown to the ground or a lower floor. Such materials that have been removed or stripped more than 50 feet above ground level, except those materials removed as units or in sections, shall be transported to the ground via dust-tight chutes or containers.

(vi) Except as specified below, the wetting requirements of this paragraph are suspended when the temperature at the point of wetting is below 0°C (32°F). When friable asbestos materials are not wetted due to freezing temperatures, such materials on pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members shall, to the maximum extent possible, be removed as units or in sections prior to wrecking. In no case shall the requirements of paragraphs (d)(4)(iv) or (d)(4)(v) be suspended due to freezing temperatures.

(vii) For renovation operations, local exhaust ventilation and collection systems may be used, instead of wetting as specified in paragraph (d)(4)(ii), to prevent emissions of particulate asbestos material to outside air when damage to equipment resulting from the wetting would be unavoidable. Upon request and supply of adequate information, the Administrator will determine whether damage to equipment resulting from wetting to comply with the provisions of this paragraph would be unavoidable. Such local exhaust ventilation systems shall be designed and operated to capture the asbestos particulate matter produced by the stripping and removal of friable asbestos material. There shall be no visible emissions to the outside air from such local exhaust ventilation and collection systems, except as provided in paragraph (f) of this section.

(5) Sources subject to this paragraph are exempt from the requirements of §§ 61.05(a), 61.07, and 61.09.

(6) The demolition of a building, structure, facility, or installation, pursuant to an order of an authorized representative of a State or local governmental agency, issued because that building is structurally unsound and in danger of imminent collapse is exempt from all but the following requirements of paragraph (d) of this section:

(i) The notification requirements specified by paragraph (d)(2) of this section;

(ii) The requirements on stripping of friable asbestos materials from previously removed units or sections as specified in paragraph (d)(4)(iv) of this section;

(iii) The wetting, as specified by paragraph (d)(4)(v) of this section, of friable asbestos materials that have been removed or stripped;

(iv) The portion of the structure being demolished that contains friable asbestos materials shall be adequately wetted during the wrecking operation.

[39 FR 15936, May 3, 1974; 40 FR 48292, October 14, 1975]

(e) *Spraying.* There shall be no visible emissions to the outside air from the spray-on application of materials containing more than 1 percent asbes-

[Sec. 61.22(e)]

a dry weight basis, used on
nt and machinery, except as
in paragraph (f) of this sec-
terials sprayed on buildings,
s, structural members, pipes,
luits shall contain less than 1
asbestos on a dry weight basis.

h (e) revised by 43 FR 26374, June

urces subject to this paragraph
ipt from the requirements of
), § 61.07, and § 61.09.

y owner or operator who in-
o spray asbestos materials
ntain more than 1 percent as-
a dry weight basis on equip-
d machinery shall report such
to the Administrator at least
prior to the commencement of
ying operation. Such report
clude the following informa-

me of owner or operator.
ddress of owner or operator.
ocation of spraying operation.
rocedures to be followed to meet
rements of this paragraph.
e spray-on application of ma-
which the asbestos fibers are
ated with a bituminous or re-
binder during spraying and
re not friable after drying is
d from the requirements of
phs (e) and (e)(2) of this sec-

phs (2) and (3) revised by 43 FR
ne 19, 1978]

ather than meet the no-visible-
requirements as specified by
phs (a), (c), (d), (e), (h), (j),
of this section, an owner or op-
ay elect to use the methods spec-
§ 61.23 to clean emissions con-
particulate asbestos material be-
h emissions escape to, or are
, the outside air.
here the presence of uncombined
the sole reason for failure to
e no-visible-emission require-
paragraphs (a), (c), (d), (e),
or (k) of this section, such fail-
not be a violation of such emis-
irements.
abricating: There shall be no
nissions to the outside air, ex-
rovided in paragraph (f) of this
from any of the following op-
if they use commercial asbestos
any building or structure in
ch operations are conducted.
: fabrication of cement building

e fabrication of friction prod-
ept those operations that pri-
stall asbestos friction materials
vehicles.
e fabrication of cement or alli-
d for ventilation hoods; ovens;
panels; laboratory furniture;
bulkheads, partitions and ceilings for marine construction; and flow control devices for the molten metal industry.

(i) Insulating: Molded insulating materials which are friable and wet-applied insulating materials which are friable after drying, installed after the effective date of these regulations, shall contain no commercial asbestos. The provisions of this paragraph do not apply to insulating materials which are spray applied; such materials are regulated under § 61.22(e).

(j) Waste disposal for manufacturing, fabricating, demolition, renovation and spraying operations: The owner or operator of any source covered under the provisions of paragraphs (c), (d), (e), or (h) of this section shall meet the following standards:

(1) There shall be no visible emissions to the outside air, except as provided in paragraph (j)(3) of this section, during the collection; processing, including incineration; packaging; transporting; or deposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing waste material shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(3) Rather than meet the requirement of paragraph (j)(1) of this section, an owner or operator may elect to use either of the disposal methods specified under (j)(3)(i) and (ii) of this section, or an alternative disposal method which has received prior approval by the Administrator:

(i) Treatment of asbestos-containing waste material with water:

(A) Control device asbestos waste shall be thoroughly mixed with water into a slurry and other asbestos-containing waste material shall be adequately wetted. There shall be no visible emissions to the outside air from the collection, mixing and wetting operations, except as provided in paragraph (f) of this section.

(B) After wetting, all asbestos-containing waste material shall be sealed into leak-tight containers while wet, and such containers shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(C) The containers specified under paragraph (j)(3)(i)(B) of this section shall be labeled with a warning label that states:

CAUTION
Contains Asbestos
Avoid Opening or Breaking Container
Breathing Asbestos is Hazardous
to Your Health

Alternatively, warning labels specified by Occupational Safety and Health Standards of the Department of Labor, Occupational Safety and Health Administration (OSHA) under 29 CFR 1910.-93a(g)(2)(ii) may be used.

(ii) Processing of asbestos-containing waste material into non-friable forms:

(A) All asbestos-containing waste material shall be formed into non-friable pellets or other shapes and deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(B) There shall be no visible emissions to the outside air from the collection and processing of asbestos-containing waste material, except as specified in paragraph (f) of this section.

(4) For the purposes of this paragraph (j), the term all asbestos-containing waste material as applied to demolition and renovation operations covered by paragraph (d) of this section includes only friable asbestos waste and control device asbestos waste.

(k) Waste disposal for asbestos mills: The owner or operator of any source covered under the provisions of paragraph (a) of this section shall meet the following standard:

(1) There shall be no visible emissions to the outside air, except as provided in paragraph (k)(3) of this section, during the collection, processing, packaging, transporting or deposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing waste material shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(3) Rather than meet the requirement of paragraph (k)(1) of this section, an owner or operator may elect to meet the following requirements in paragraphs (k)(3)(i) and (ii), or use an alternative disposal method which has received prior approval by the Administrator:

(i) There shall be no visible emissions to the outside air from the transfer of control device asbestos waste to the tailings conveyor, except as provided in paragraph (f) of this section. Such waste shall be subsequently processed either as specified in paragraph (k)(3)(ii) of this section or as specified in paragraph (j)(3) of this section.

(ii) All asbestos-containing waste material shall be adequately mixed, with a wetting agent recommended by the manufacturer of the agent to effectively wet dust and tailings, prior to deposition at a waste disposal site. Such agent shall be used as recommended for the particular dust by the manufacturer of the agent. There shall be no discharge of visible emissions to the outside air from the wetting operation except as specified in paragraph (f) of this section. Wetting may be suspended when the ambient temperature at the waste disposal site is less than −9.5°C (ca. 15°F). The ambient air temperature shall be determined by an appropriate measurement method with an accuracy of ±1°C (±2°F) and recorded at least at hourly intervals during the period that the operation of the wetting system is suspended. Records of

ch temperature measurements shall be tained at the source for a minimum of ro years and made available for inspec- on by the Administrator.

(i) The owner of any inactive waste sposal site, which was operated by urces covered under § 61.22 (a), (c) or) and where asbestos-containing waste aterial produced by such sources was posited, shall meet the following ndards:

(1) There shall be no visible emissions the outside air from an inactive waste sposal site subject to this paragraph, cept as provided in paragraph (i)(5) this section.

(2) Warning signs shall be displayed all entrances, and along the property ne of the site or along the perimeter of ie sections of the site where asbestos- ntaining waste material was deposited, intervals of 100 m (ca. 330 ft) or less, cept as specified in paragraph (i)(4) this section. Signs shall be posted in ch a manner and location that a person ay easily read the legend. The warning gns required by this paragraph shall nform to the requirements of 20" x 14" pright format signs specified in 29 CFR 910.145(d)(4) and this paragraph. The gns shall display the following legend the lower panel, with letter sizes and yles of a visibility at least equal to those pecified in this paragraph.

LEGEND

ASBESTOS WASTE DISPOSAL SITE

Do Not Create Dust

Breathing Asbestos is Hazardous to Your Health

Notation

1" Sans Serif, Gothic or Block

¾" Sans Serif, Gothic or Block

14 Point Gothic

pacing between lines shall be at least qual to the height of the upper of the wo lines.

(3) The perimeter of the site shall be enced in a manner adequate to deter ccess by the general public, except as pecified in paragraph (i)(4) of this ection.

(4) Warning signs and fencing are not equired where the requirements of aragraphs (i)(5) (i) or (ii) of this sec- ion are met, or where a natural barrier dequately deters access by the general ublic. Upon request and supply of ap- ropriate information, the Adminis- rator will determine whether a fence or natural barrier adequately deters ac- ess to the general public.

(5) Rather than meet the requirement f paragraph (i)(1) of this section, an wner may elect to meet the require- ents of this paragraph or may use an lternative control method for emissions rom inactive waste disposal sites which as received prior approval by the dministrator.

(i) The asbestos-containing waste material shall be covered with at least 15 centimeters (ca. 6 inches) of compacted non-asbestos-containing material, and a cover of vegetation shall be grown and maintained on the area adequate to prevent exposure of the asbestos-containing waste material; or

(ii) The asbestos-containing waste material shall be covered with at least 60 centimeters (ca. 2 feet) of compacted non-asbestos-containing material and maintained to prevent exposure of the asbestos-containing waste; or

(iii) For inactive waste disposal sites for asbestos tailings, a resinous or petroleum-based dust suppression agent which effectively binds dust and controls wind erosion shall be applied. Such agent shall be used as recommended for the particular asbestos tailings by the dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

[40 FR 48292, October 14, 1975]

§ 61.23 Air-cleaning.

If air-cleaning is elected, as permitted by §§ 61.22(f) and 61.22(d)(4)(iv), the requirements of this section must be met.

[40 FR 48292, October 14, 1975]

(a) Fabric filter collection devices must be used, except as noted in paragraphs (b) and (c) of this section. Such devices must be operated at a pressure drop of no more than 4 inches water gage, as measured across the filter fabric. The airflow permeability, as determined by ASTM method D737-69, must not exceed 30 ft³/min/ft² for woven fabrics or 35 ft³/min/ft² for felted fabrics, except that 40 ft³/min/ft² for woven and 45 ft³/min/ft² for felted fabrics is allowed for filtering air from asbestos ore dryers. Each square yard of felted fabric must weigh at least 14 ounces and be at least one-sixteenth inch thick throughout. Synthetic fabrics must not contain fill yarn other than that which is spun.

(b) If the use of fabric filters creates a fire or explosion hazard, the administrator may authorize the use of wet collectors designed to operate with a unit contacting energy of at least 40 inches water gage pressure.

(c) The administrator may authorize the use of filtering equipment other than that described in paragraphs (a) and (b) of this section if the owner or operator demonstrates to the satisfaction of the administrator that the filtering of particulate asbestos material is equivalent to that of the described equipment.

(d) All air-cleaning equipment authorized by this section must be properly installed, used, operated, and maintained. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

§ 61.24 Reporting.

The owner or operator of any existing source to which this subpart is applicable shall, within 90 days after the effective date, provide the following information to the administrator:

(a) A description of the emission control equipment used for each process;

(b) If a fabric filter device is used to control emissions, the pressure drop across the fabric filter in inches water gage.

(1) If the fabric filter device utilizes a woven fabric, the airflow permeability in ft³/min/ft²; and, if the fabric is synthetic, indicate whether the fill yarn is spun or not spun.

(2) If the fabric filter device utilizes a felted fabric, the density in oz/yd², the minimum thickness in inches, and the airflow permeability in ft³/min/ft².

(c) For sources subject to §§ 61.22(j) and 61.22(k):

(1) A brief description of each process that generates asbestos-containing waste material.

(2) The average weight of asbestos-containing waste material disposed of, measured in kg/day.

(3) The emission control methods used in all stages of waste disposal.

(4) The type of disposal site or incineration site used for ultimate disposal, the name of the site operator, and the name and location of the disposal site.

(d) For sources subject to § 61.22(l):

(1) A brief description of the site.

(2) The method or methods used to comply with the standard, or alternative procedures to be used.

(e) Such information shall accompany the information required by § 61.10. The information described in this section shall be reported using the format of Appendix A of this part.

[40 FR 48292, October 14, 1975]

§ 61.25 Waste disposal sites.

In order to be an acceptable site for disposal of asbestos-containing waste material under § 61.22 (j) and (k), an active waste disposal site shall meet the requirements of this section.

(a) There shall be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited, except as provided in paragraph (e) of this section.

(b) Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material is deposited, at intervals of 100 m (ca. 330 ft) or less except as specified in paragraph (d) of this section. Signs shall be posted in such

nd location that a person may
the legend. The warning
red by this paragraph shall
the requirements of 20" x 14"
mat signs specified in 29 CFR
(4) and this paragraph. The
display the following legend
r panel, with letter sizes and
visibility at least equal to
fied in this paragraph.

LEGEND

TOS WASTE DISPOSAL SITE
Do Not Create Dust
Breathing Asbestos
Hazardous to Your Health
Notation
ans Serif, Gothic or Block
ans Serif, Gothic or Block
14 Point Gothic

tween lines shall be at least
e height of the upper of the

perimeter of the disposal site
nced in order to adequately
s to the general public except
d in paragraph (d) of this

ning signs and fencing are
d where the requirements of
(e)(1) of this section are
here a natural barrier ade-
ters access to the general
n request and supply of ap-
nformation, the Administra-
ermine whether a fence or a
rrier adequately deters access
al public.

er than meet the require-
agraph (a) of this section, an
perator may elect to meet
nents of paragraph (e)(1) or
is section, or may use an al-
ntrol method for emissions
waste disposal sites which
d prior approval by the
or.

end of each operating day,
once every 24-hour period
e is in continuous operation,
-containing waste material
leposited at the site during
g day or previous 24-hour
be covered with at least 15
(ca. 6 inches) of compacted
-containing material.

end of each operating day,
once every 24-hour period
sposal site is in continuous
e asbestos-containing waste
ch was deposited at the site
erating day or previous 24-
hall be covered with a res-
oleum-based dust suppres-
hich effectively binds dust
wind erosion. Such agent
as recommended for the
st by the dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

[40 FR 48292, October 14, 1975]

(Sec. 114 of the Clean Air Act as amended (42 U.S.C. 7414))

Subpart C—National Emission Standard for Beryllium

§ 61.30 Applicability.

The provisions of this subpart are applicable to the following stationary sources:

(a) Extraction plans, ceramic plants, foundries, incinerators, and propellant plants which process beryllium ore, beryllium, beryllium oxide, beryllium alloys, or beryllium-containing waste.

(b) Machine shops which process beryllium, beryllium oxides, or any alloy when such alloy contains more than 5 percent beryllium by weight.

§ 61.31 Definitions.

Terms used in this subpart are defined in the act, in subpart A of this part, or in this section as follows:

(a) "Beryllium" means the element beryllium. Where weights or concentrations are specified, such weights or concentrations apply to beryllium only, excluding the weight or concentration of any associated elements.

(b) "Extraction plant" means a facility chemically processing beryllium ore to beryllium metal, alloy, or oxide, or performing any of the intermediate steps in these processes.

(c) "Beryllium ore" means any naturally occurring material mined or gathered for its beryllium content.

(d) "Machine shop" means a facility performing cutting, grinding, turning, honing, milling, deburring, lapping, electrochemical machining, etching, or other similar operations.

(e) "Ceramic plant" means a manufacturing plant producing ceramic items.

(f) "Foundry" means a facility engaged in the melting or casting of beryllium metal or alloy.

(g) "Beryllium-containing waste" means material contaminated with beryllium and/or beryllium compounds used or generated during any process or operation performed by a source subject to this subpart.

(h) "Incinerator" means any furnace used in the process of burning waste for the primary purpose of reducing the volume of the waste by removing combustible matter.

(i) "Propellant" means a fuel and oxidizer physically or chemically combined which undergoes combustion to provide rocket propulsion.

(j) "Beryllium alloy" means any metal to which beryllium has been added in order to increase its beryllium content and which contains more than 0.1 percent beryllium by weight.

(k) "Propellant plant" means any facility engaged in the mixing, casting, or machining of propellant.

§ 61.32 Emission standard.

(a) Emissions to the atmosphere from stationary sources subject to the provisions of this subpart shall not exceed 10 grams of beryllium over a 24-hour period, except as provided in paragraph (b) of this section.

(b) Rather than meet the requirement of paragraph (a) of this section, an owner or operator may request approval from the Administrator to meet an ambient concentration limit on beryllium in the vicinity of the stationary source of 0.01 $\mu g/m^3$, averaged over a 30-day period.

(1) Approval of such requests may be granted by the Administrator provided that:

(i) At least 3 years of data is available which in the judgment of the Administrator demonstrates that the future ambient concentrations of beryllium in the vicinity of the stationary source will not exceed 0.01 $\mu g/m^3$, averaged over a 30-day period. Such 3-year period shall be the 3 years ending 30 days before the effective date of this standard.

(ii) The owner or operator requests such approval in writing within 30 days after the effective date of this standard.

(iii) The owner or operator submits a report to the Administrator within 45 days after the effective date of this standard which report includes the following information:

(a) Description of sampling method including the method and frequency of calibration.

(b) Method of sample analysis.

(c) Averaging technique for determining 30-day average concentrations.

(d) Number, identity, and location (address, coordinates, or distance and heading from plant) of sampling sites.

(e) Ground elevations and height above ground of sampling inlets.

(f) Plant and sampling area plots showing emission points and sampling sites. Topographic features significantly affecting dispersion including plant building heights and locations shall be included.

(g) Information necessary for estimating dispersion including stack height, inside diameter, exit gas temperature, exit velocity or flow rate, and beryllium concentration.

(h) A description of data and procedures (methods or models) used to de-

A-3261

INDUSTRIAL HYGIENE SAMPLING SURVEY

at

ZEP MANUFACTURING COMPANY
1310 Seaboard Industrial Boulevard, N.W.
Atlanta, Georgia

for

MCLAIN AND MERRITT, P.C.
1250 Tower Place
Atlanta, Georgia 30026-3901

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Occupational Safety and Health Division
Atlanta, Georgia
October 29, 1982

Project No. A-3261

CONTENTS

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1.0 INTRODUCTION

At the request of Mr. Robert Hill of McLain and Merritt, P.C., an industrial hygiene sampling survey was conducted at the distribution warehouse of ZEP Manufacturing Company's 1310 Seaboard Industrial Boulevard, N.W., Atlanta, Georgia facility. The survey was conducted by Mr. William M. Ewing of the Georgia Institute of Technology, Engineering Experiment Station, on August 19, 1982.

The purpose of the survey was to determine carbon monoxide exposure for selected employees working in the distribution warehouse. In addition, concentrations of organic vapors were measured to estimate leakage from products stored in this area. Also included is a review of work and housekeeping practices and recommendations for improved general ventilation. The following report summarizes the results of the survey.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 Area air sampling indicated the potential for employee exposure to carbon monoxide in excess of the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 50 parts per million (ppm), determined as an 8-hour, time-weighted average (TWA). The area of greatest concern is the back loading docks. Exposures would be expected to be the highest during the winter months when general ventilation is reduced.

2.2 Personal samples collected for two lift-truck operators did not exceed the OSHA 8-hour, TWA limit on the day of the survey. Neither of the lift-truck operators sampled, remained in the back loading area for extended periods of time.

2.3 Ventilation measurements indicated stagnent air in the back loading area. Additional general ventilation should be supplied to this area through the use of tempered make-up air and ceiling fans.

2.4 Reducing the amount of carbon monoxide may reduce the number of safety-related accidents since carbon monoxide reduces the alertness of the employees. This is discussed in greater detail in section 4.1 of this report.

2.5 Area air measurements showed that carbon monoxide is slowly drawn into the repair shop from the back loading area. Carbon monoxide concentrations measured in the repair shop exceeded 50 ppm.

2.6 The carbon monoxide could be eliminated by switching to electric-powered lift trucks. Alternatively, the existing lift-trucks should be tuned frequently to minimize carbon monoxide emissions.

2.7 Personal and area air sampling should be conducted during the winter months to estimate employee exposure to carbon monoxide when the loading dock doors are closed. Ventilation measurements should be repeated at this time.

2.8 Air sampling indicated quantities of numerous species of organic vapors present in the workplace air. These vapors may be the result of product leakage in the warehouse; however, it is more likely that these vapors are the result of migration from the lower soaphouse. Improved ventilation in the lower soaphouse should reduce these vapor concentrations.

2.9 The presence of these organic vapors may be responsible for the reduced lifespan of the overhead heaters reported by Zep management.

2.10 Housekeeping appeared adequate throughout the distribution warehouse. All aisles and fire fighting equipment should be kept free of obstructions.

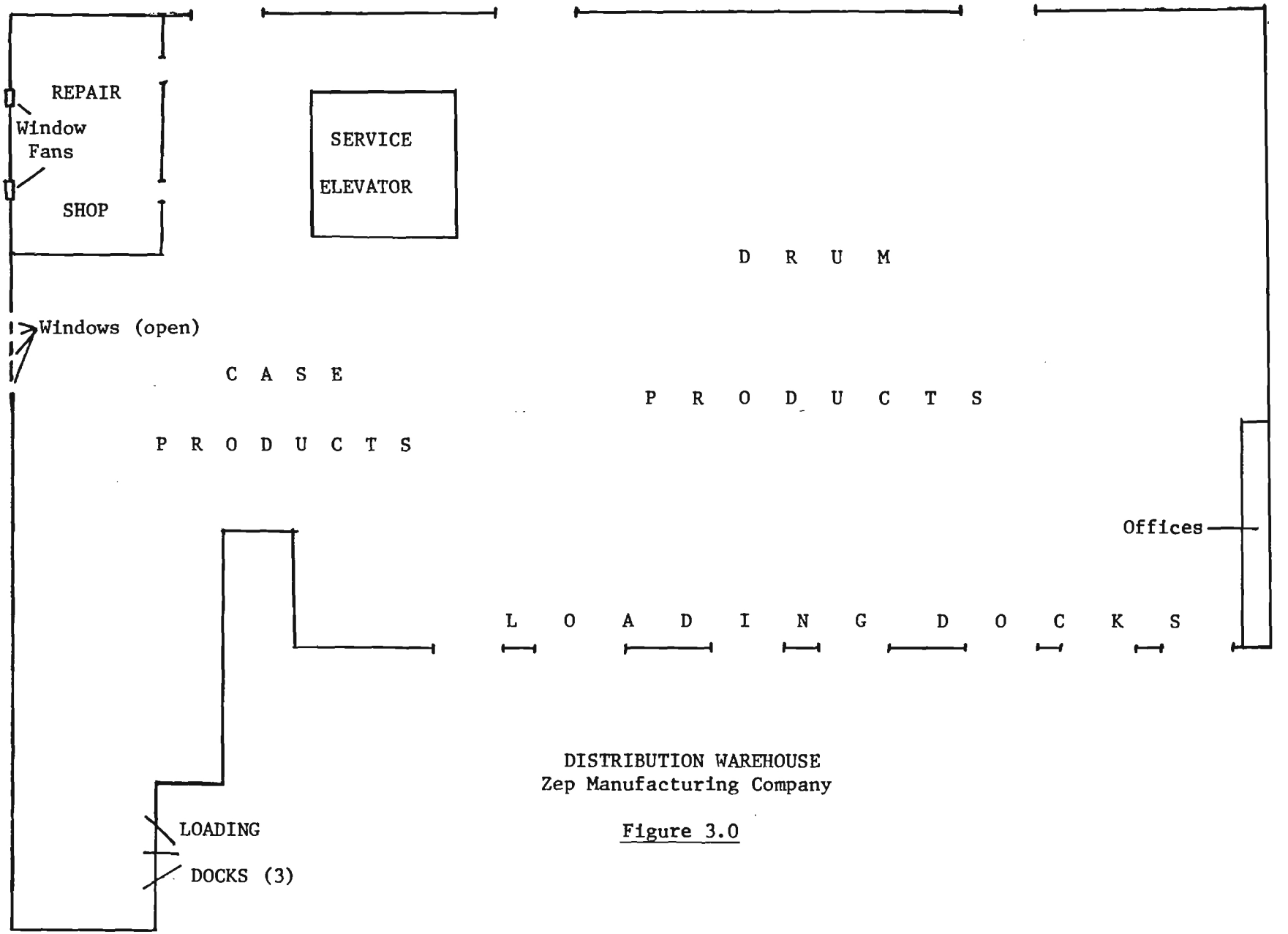
2.11 Trailers should always be chocked during loading to prevent a serious accident when the lift-trucks enter the trailers.

3.0 DESCRIPTION OF OPERATIONS

ZEP Manufacturing Company is engaged in the production of commercial, institutional, and industrial chemicals for use in sanitation and maintenance. Products include liquids, powders, and a wide variety of aerosols and sprays which are used as waxes, polishes, water treatment chemicals, deodorants, cleaners, disinfectants, degreasers, weed killers, insecticides, and for a multitude of other purposes. The Atlanta facility manufacturers approximately 90% of the product range offered by ZEP Manufacturing. This is the only facility which manufacturers acid and aerosol products for ZEP. The facility consists of five production areas, warehouse facilities, quality control laboratory, and the general offices. The scope of this survey called for concentrating efforts in the distribution warehouse.

3.1 DISTRIBUTION WAREHOUSE

The distribution warehouse is the storage facility for products to be shipped by truck. Lift-trucks (propane) are used to transport case good and drum products to the 10 loading docks where they are placed in trailers for shipment. Figure 3.0 is a sketch of the warehouse.



DISTRIBUTION WAREHOUSE
Zep Manufacturing Company

Figure 3.0

4.0 DISCUSSION OF FINDINGS

4.1 CARBON MONOXIDE

Personal and area samples were collected to measure employee exposure to carbon monoxide. Two personal samples taken for lift-truck operators indicated 19 and 31 ppm carbon monoxide, determined as 8-hour, TWAs. These values did not exceed the current OSHA PEL of 50 ppm carbon monoxide, based on an 8-hour, TWA exposure. It was noted, however, that all the loading dock doors remained open during the day increasing general ventilation. Accordingly, 8-hour exposure values to carbon monoxide would be expected to be higher during the winter months when these doors are closed.

The area samples indicated excessive carbon monoxide in the back loading area. At one point the concentration reached 280 ppm carbon monoxide. It should be noted that the concentration will vary depending on several factors. These factors include the number of lift-trucks operating, the lift-truck operator's driving habits, the number of open doors (loading docks) and windows, and the operating efficiency of each lift truck. Figure 4.0 depicts the carbon monoxide concentration at various locations in the warehouse at one point in the afternoon. Figure 4.1 depicts the air flow patterns in the same building during that time.

From these data, it may be concluded that carbon monoxide concentrations build-up in the back loading docks and is slowly diluted as it moves in the direction of the repair shop. The greatest risk to employees will occur during the winter months when dilution ventilation becomes minimal.

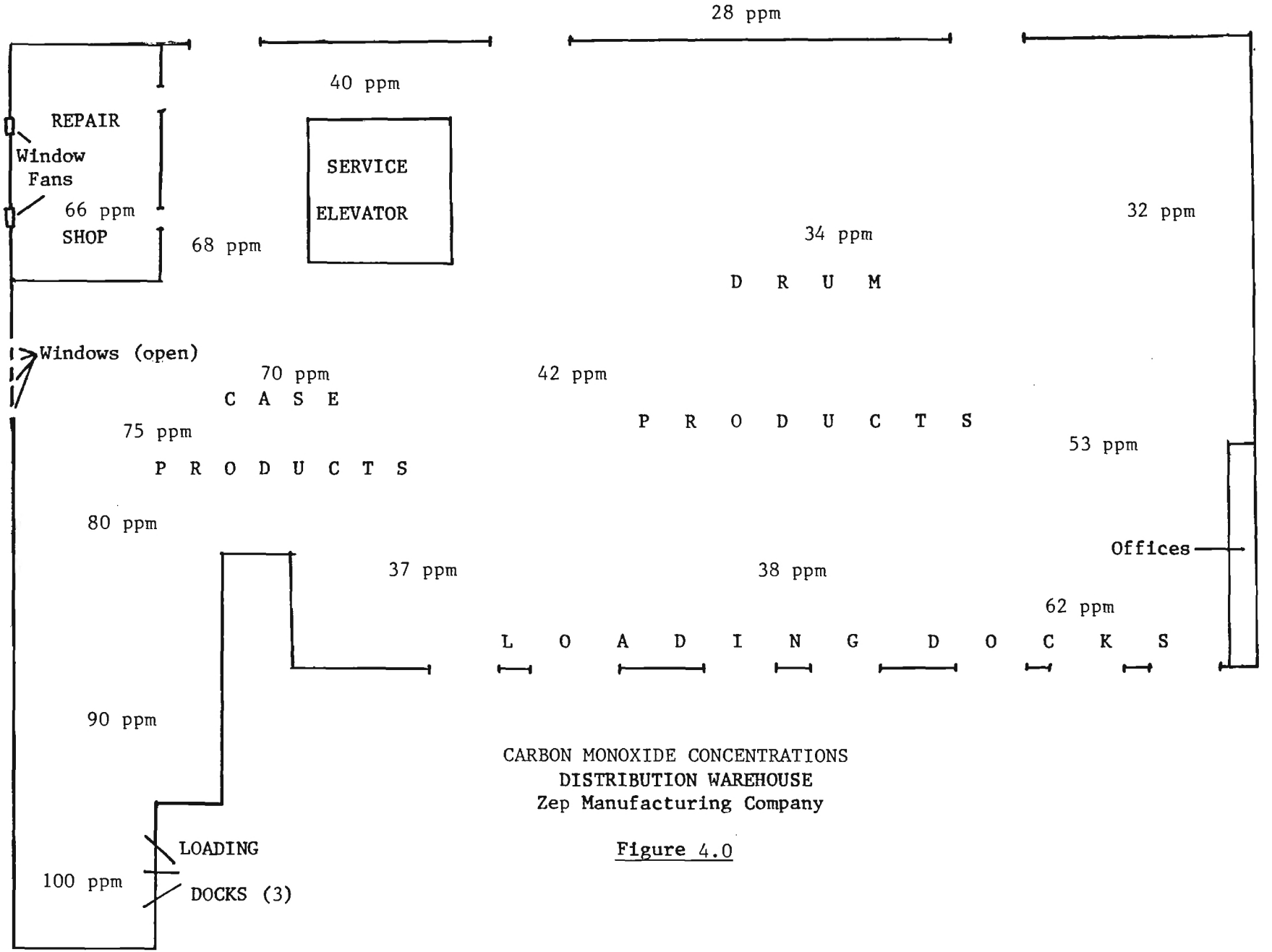
The effects of carbon monoxide on the employee are many, and have been summarized in Appendix C of this report. It should be noted that the National Institute for Occupational Safety and Health (NIOSH) criteria document states that exposure to low concentrations of carbon monoxide may result in reduced reaction time and awareness of safety hazards.

An additional problem arises when lift-trucks enter the trailers to load drums and products. Inadequate ventilation inside the trailer allows carbon monoxide concentrations to build-up increasing the risk to employee working in the trailer stacking products. This problem is minimized at this location by providing fans at the entrance to each trailer to force air into them.

Area measurements indicated excessive amounts of carbon monoxide in the repair shop. There are no apparent sources of combustion products in the shop. The ventilation measurements indicate that the carbon monoxide is coming from the back loading docks and case products area. This air is drawn into the repair shop by the two window fans located in this area.

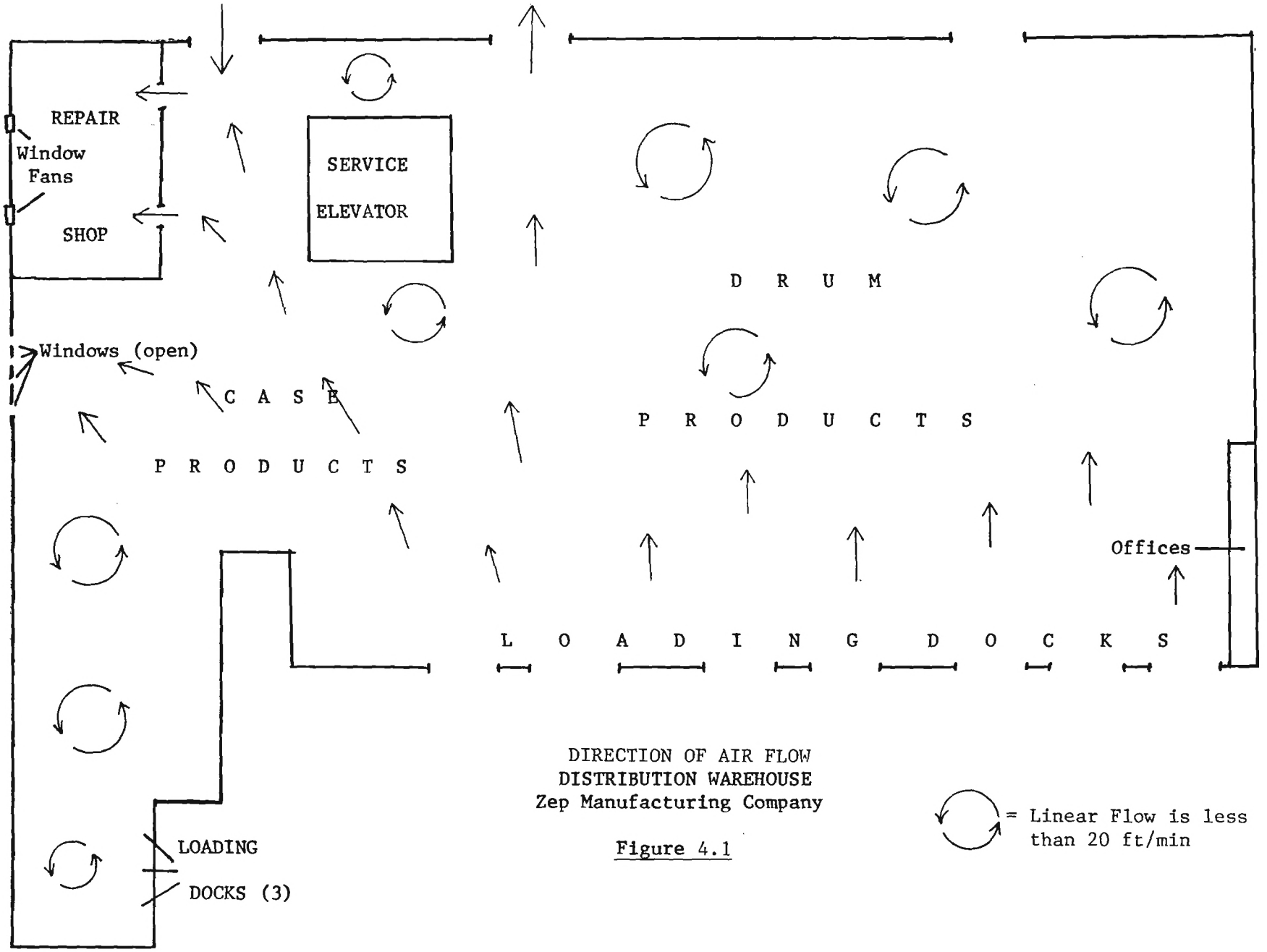
4.2 GENERAL VENTILATION

Figure 4.1 is a sketch of the distribution warehouse depicting air flow patterns. From these measurements, it is evident that the stagnent air



CARBON MONOXIDE CONCENTRATIONS
DISTRIBUTION WAREHOUSE
Zep Manufacturing Company

Figure 4.0



DIRECTION OF AIR FLOW
DISTRIBUTION WAREHOUSE
Zep Manufacturing Company

= Linear Flow is less than 20 ft/min

Figure 4.1

(less than 20 ft/min) in the back loading area allows exhaust gases (including carbon monoxide) to accumulate. These measurements further support the conclusion that the carbon monoxide in the repair shop results from carbon monoxide present in the warehouse. It is interesting to note that supply air was entering the warehouse through the open loading dock doors. When these doors are closed during cold days the air flow patterns may be considerably different.

4.3 ORGANIC VAPORS

Two area samples were collected and analyzed for a variety of organic vapors which might be present due to product leakage. Table 4.2 summarizes the results of analyses of these samples by gas chromatography. No product spills were evident during the sampling period. There is a distinct possibility that these organic vapors may be due to migration from the lower soaphouse. Sampling conducted during the same time period in the lower soaphouse indicated the presence of identical compounds. It is also possible that some of the vapors are the result of minor leakage in some product containers.

As with carbon monoxide, the concentration of various organic vapors would be expected to increase during the winter months when the loading dock doors are closed to conserve energy. It is possible that the presence of these vapors are responsible for the reduced lifespan of the overhead heaters. It is probable that spills of acids on occassion also adversely affect the lifespan of thse heaters. The acid gases (hydrogen chloride and hydrogen fluoride) producted during such a spill would be corrosive to the heating elements.

4.4 MISCELLANEOUS

It was noted that several trailers were not chocked when loading was in progress. This presents a serious safety hazard since the trailer can be pushed away from the loading dock by the action of the lift-truck. This is a common industrial accident when the lift-truck falls between the trailer and the loading dock.

Housekeeping appeared adequate throughout the distribution warehouse. All aisles should be kept clear of obstructions in case of fire.

This Report Prepared By:

William M. Ewing

This Report Approved By:

James L. Burson

WME:JLB:sek

TABLE 4.2

SUMMARY OF RESULTS OF AREA SAMPLING

Not Detected	Detected (Trace Amount)	Detected Range (ppm)
Butyl Cellosolve	n-Hexane	1,1,1-Trichloroethane (1.18-1.97)
1,2-Epoxy Butane	Ethyl Benzene	Methylene Chloride (1.91-2.01)
Isopropanol	p-Ethyl Toluene	Perchlorothylene (1.18-1.71)
	o-Dichlorobenzene	Toluene (0.34-0.46)
	p-Dichlorobenzene	Xylene (0.25-0.32)
	C_8-C_{10} Aromatics	Trimethylbenzene (0.07-0.07)
		Hexane Equivalent (1.38-2.14)

APPENDIX A

Results of Sampling

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant ZEP Manufacturing Company
Atlanta, Georgia (Distribution Warehouse)

Materials Carbon Monoxide (CO)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			CO (ppm*)	
8/19	CO-30	D. Woods, Lift-truck Operator Back 3 loading docks	0922	1503	8.0	401	31	
8/19	CO-40	M. Lamar, Lift-truck operator case goods	0925	1355	5.4	270	19	

*parts per million

TABLE A-2

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant ZEP Manufacturing

Atlanta, Georgia (Distribution Warehouse)

Materials Hexane Equivalent (THC), 1,1,1-Trichloroethane (1,1,1-T), Methylene Chloride (MeCl), Perchloroethylene (Per), Toluene, Xylene, 1,2,4-Trimethylbenzene (TMB)

Date 1982	**Sample Number**	**Description**	**Sampling Period**		Concentrations						
			Start	**Stop**	THC (ppm)	1,1,1-T (ppm)	MeCl (ppm)	Per (ppm)	Toluene (ppm)	Xylene (ppm)	TMB (ppm)
8/19	CT-36	Area Sample, Center of Drum Products Storage Area	0932	1504	2.14	1.97	2.01	1.71	0.46	0.25	0.07
8/19	CT-37	Area Sample, Center of Case Goods Storage Area	0935	1502	1.38	1.18	1.91	1.18	0.34	0.32	0.07

APPENDIX B

Sampling and Analytical Methods

CARBON MONOXIDE

Sampling for carbon monoxide (CO) was conducted by using the following two techniques.

Short-term area sampling (direct reading instantaneous) was performed either by drawing measured volumes of air through a length of stain detector tube via a hand-operated sampling pump, or by a direct-reading meter.

In the detector tube system, the CO indication is based upon the reduction of potassium palladosulfite impregnated silica gel giving a color change of yellow to brown in the presence of CO. The length of stain of the detector chemical is proportional to the CO concentration (in ppm) and must be matched to a chart corresponding to the number of pump strokes employed (1 full stroke = 100 cc) on the instruction sheet which accompanies the tubes.

The basic principle of operation of the direct reading meter involves drawing air (pre-cleansed to remove interferences) through an electrochemical sensor cell at a nominal flowrate of 700 cc/minute. The sensor cell is composed of a catalytically active sensing electrode (platinum), a counter electrode, a reference electrode and an aqueous sulfuric acid solution as the electrolyte. In the direct reading meter, the electrochemical process is carried out at a potential-controlled electrode. The current measured upon introduction of CO to the sensor cell is the result of the electro-oxidation of CO to carbon dioxide (CO_2) and is proportional to the partial pressure of CO in the sampled air.

ORGANIC VAPORS

Samples were collected by using battery-powered, portable pumps to draw air at measured flowrates through:

1. Charcoal Sample Collection Tubes, containing 450-milligram (front) and 150-milligram (back) sections of activated charcoal, or

2. Charcoal Tubes containing 100-milligrams (front) and 50-milligram (back) sections of activated charcoal.

Immediately after sampling, the ends of tubes were sealed with polyethylene caps for transport to the laboratory, where they were refrigerated until analysis.

In the laboratory, front and back sections of each tube were desorbed separately in appropriate volumes of carbon disulfide, and aliquots of the resultant solutions injected into a gas chromatograph. Quantites of each analyte present were determined by comparison of areas under the sample chromatogram peaks with areas under chromatogram peaks for standards prepared in carbon disulfide. Analytical results, which include any necessary corrections for parallel blank and recovery determinations, were used in conjunction with sampling data (volume of air sampled) to calculate the concentrations of airborne analytes represented by each sample, expressed in parts analyte per million parts of air, by volume (ppm).

APPENDIX C

Toxicological Information

CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless gas generally produced by incomplete combustion of organic or carbonaceous materials. It is a serious hazard in many processes in the chemical, iron and steel, pottery, automobile, and mining industries.

Of all the gases that have poisonous effects upon man and animals, carbon monoxide is the most widely encountered. It exerts its effects by combining with the hemoglobin of the blood and interrupting the normal oxygen supply to the body tissues. Although this resultant oxygen deficiency is a reversible chemical asphyxia, nevertheless, damage done by severe asphyxia from any cause may not be reversible.

The acute effects of carbon monoxide exposures are dependent on the percentage saturation of hemoglobin with carbon monoxide, which in turn is dependent on the duration of exposure, concentration of carbon monoxide, the ambient temperature, and the health status and metabolic efficiency of the worker. The approximate relationship is shown in the following table.

Atmospheric Carbon monoxide concentration (ppm)	Half-time for accumulation (min)	Carboxy-hemoglobin concentration at equilibrium %	Principal Symptoms
50	150	7	Slight headache
100	120	12	Moderate headache and dizziness
250	120	25	Severe headache and dizziness
500	90	45	Nausea, vomiting collapse possible
1,000	60	60	Coma
10,000	5	95	Death

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established a permissible exposure limit (PEL) for an eight-hour, time-weighted average, (TWA) exposure of 50 ppm to maintain carboxyhemoglobin levels below 10%. The National Institute for Occupational Safety and Health recommends a time-weighted average exposure of 35 ppm for an eight-hour workday, with a ceiling concentration of 200 ppm. ACGIH currently lists as "tentative value" a short-term exposure limit (up to 15 minutes) of 400 ppm.

A-3261

INDUSTRIAL HYGIENE SAMPLING SURVEY

at

ZEP MANUFACTURING COMPANY

1310 Seaboard Industrial Boulevard, N.W.

Atlanta, Georgia

for

MCLAIN AND MERRITT, P.C.

1250 Tower Place

Atlanta, Georgia 30026-3901

GEORGIA INSTITUTE OF TECHNOLOGY

Engineering Experiment Station

Occupational Safety and Health Division

Atlanta, Georgia

November 5, 1982

Project No. A-3261

CONTENTS

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1.0 INTRODUCTION

At the request of Mr. Robert Hill of McLain and Merritt, P.C., an industrial hygiene sampling survey was conducted at the aerosol house of ZEP Manufacturing Company's 1310 Seaboard Industrial Boulevard, N.W., Atlanta, Georgia facility. The survey was conducted by Mr. William M. Ewing of the Georgia Institute of Technology, Engineering Experiment Station, on August 17 and September 30, 1982.

The purpose of the survey was to measure employee exposure to selected organic vapors, carbon monoxide, and noise during an 8-hour workday. The following report summarizes the results of the survey including conclusions and recommendations, where necessary.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 Results of six personal samples, in use on the days of the sampling surveys, did not indicate any exposure to 13 organic vapors above the current Occupational Safety and Health Administration (OSHA) permissable exposure limits (PELs) for each compound, determined as 8-hour, time-weighted averages (TWAs).

2.2 The measured 8-hour TWA exposures also did not exceed the current recommended PELs set by the National Institute for Occupational Safety and Health (NIOSH) or the current threshold limit values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) for these organic vapors.

2.3 The data indicate the potential for exposure to a wide range of chemical compounds during any given day. Very little data is available concerning synergistic effects of compounds on the body. Accordingly, Zep Manufacturing should continue in their endeavors to minimize employee exposure to all chemical contaminants.

2.4 It should be noted that methylene chloride has recently been found to cause cancer in laboratory animals, according to the National Toxicology

Program (Chemical & Engineering News, October 4, 1982, p. 13). The recommended limits in Table I were promulgated before this information was available. At the present time, further information regarding recommended actions has not been released by NIOSH or OSHA. Accordingly, every effort should be made to minimize employee exposure to methylene chloride until further information is available.

2.5 When the new aerosol house facilities are constructed, local exhaust ventilation should be supplied at each can filling location. The minimum capture velocity should be 100 feet per minute (ft/min).

2.6 Two personal samples indicated employee exposure to carbon monoxide below the current OSHA PEL of 50 parts per million (ppm), determined as 8-hour, TWAs. Area sampling, however, revealed the potential for carbon monoxide build-up during times of reduced general ventilation such as during winter months when loading dock doors remain shut.

2.7 If the propane-fired lift-truck is to be used in the new aerosol house location, general ventilation should be adequate to maintain carbon monoxide concentrations below 50 ppm. Personal sampling should be conducted at that time to determine if the levels are below the OSHA PEL.

2.8 Noise dosimetry showed that employees working at the can filling and leak checking areas are exposed to noise above the current OSHA "action level" but below the current OSHA PEL.

2.9 Employees exposed above the OSHA "action level" of 85 dBA continuous noise for 8 hours should be enrolled in an effective hearing conservation program. This program should include training, audiometric testing, and the availability of hearing protection devices.

2.10 As an alternative to the hearing conservation program, noise may be reduced at the source through engineering controls. If these controls reduce employee exposure below the action level then further action is not required by OSHA.

2.11 The three primary noise sources identified were noise emitted from the propellant pressurizing room, can-to-can impacts, and noise emitted by the nozzles of the air blowers used to eject water from the can tops immediately subsequent to the leak check area. When the new facilities are constructed, the propellant room may be insulated with commercially available acoustical materials to reduce noise at the source. Any other control measure may be considered at that time, as needed.

2.12 Employee noise exposure should be measured once the new aerosol facility is operational.

2.13 Employees are not aware of the hazards of chemicals in use on a daily basis or what precautions should be followed to minimize exposure to them. All bulk containers should be labeled indicating its contents and any necessary precautionary statements affixed to them. During the

periodic safety meetings employees should be told (repeatedly) of the hazards of the various chemicals and what measures to take to protect themselves.

2.14 The compounder should wear appropriate personal protective equipment. At a minimum this should include neoprene gloves (not leather or rubber), an apron, boots, and goggles (not safety glasses alone).

2.15 Aisles should be kept free of obstructions at all times to be accessable in the event of a fire.

2.16 The eye wash station along the south wall of the aerosol house should be repaired and remain accessable at all times. Either the eye wash or the electric lift-truck charging station should be moved to minimize the risk of electrocution.

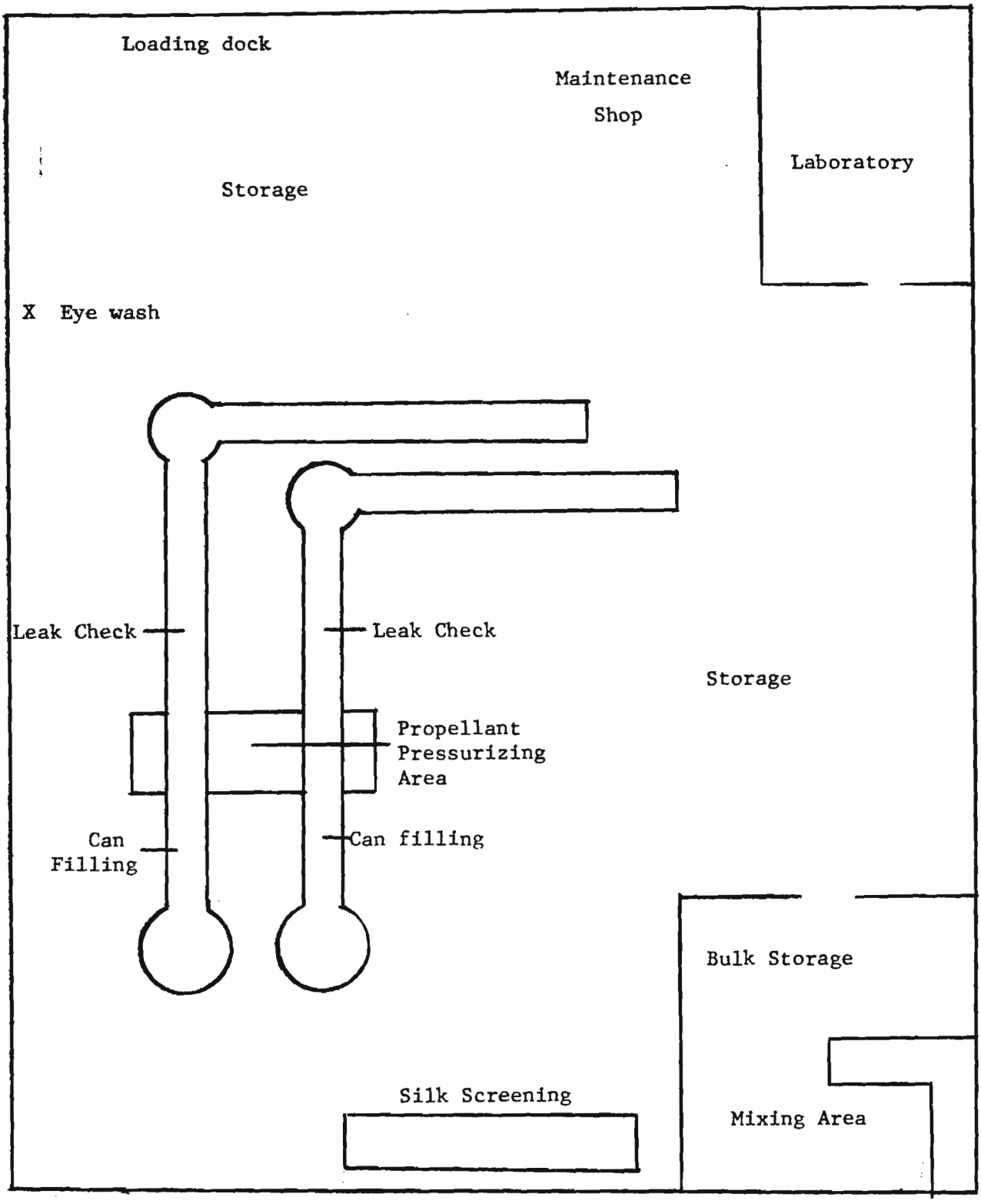
2.17 Several deficiencies were noted at the chemical storage area behind the aerosol house. Recommendations concerning this item are included in section 4.4 of this report.

3.0 DESCRIPTION OF OPERATIONS

ZEP Manufacturing Company is engaged in the production of commercial, institutional, and industrial chemicals for use in sanitation and maintenance. Products include liquids, powders, and a wide variety of aerosols and sprays which are used as waxes, polishes, water treatment chemicals, deodorants, cleaners, disinfectants, degreasers, weed killers, insecticides, and for a multitude of other purposes. The Atlanta facility manufacturers approximately 90% of the product range offered by ZEP Manufacturing. This is the only facility which manufacturers acid and aerosol products for ZEP. The facility consists of five production areas, warehouse facilities, quality control laboratory, and the general offices. The scope of this survey called for concentrating efforts in the aerosol house.

3.1 AEROSOL HOUSE

The aerosol house (Figure 3.0-1), located on the south side of Seaboard Industrial Drive, is responsible for the mixing of various compounds and packaging them into aerosol cans. The mixing area is located in the southeast corner of this facility and normally employs one operator. Four mix tanks are located in this area. The addition of chemical solutions to the tanks are made from a raised platform. After mixing, the solutions are packaged in aerosol cans beginning at the south end of either of two packaging lines. After filling, the cans pass through the propellant station where they are pressurized. This area is enclosed to protect workers in case of ruptures to the cans during this process. Under normal operations the pressurizing agent used is carbon dioxide or LP gas. The spray caps are then placed on the cans and each can is tested and leak-checked. The remainder of the operation consists of capping the cans with protective caps and packaging for storage and subsequent shipment. Approximately eight employees are engaged in the filling process and an additional ten employees in the quality control and packaging operations.



Zep Manufacturing Company
Aerosol House

Figure 3.0-1

On the first day of the survey (8/17/82) both filling lines were in operation. On the second day of the survey (9/30/82), only one line was operating.

4.0 DISCUSSION OF FINDINGS

4.1 ORGANIC VAPORS

Six personal samples were collected and analyzed for numerous organic compounds in use on the days of the survey. The samples measured exposure to the compounds listed below for employees filling cans with the product, checking leaking, and mixing the product (compounder).

n-hexane	Ethyl benzene
Hexane equivalent	p-ethyl toluene
1,2-epoxy butane	Trimethylbenzene
1,1,1-trichloroethane	C_8-C_{10} aromatic hydrocarbons
Methylene chloride	Butyl cellosolve
Perchloroethylene	o-dichlorobenzene
Toluene	p-dichlorobenzene
Xylenes	

The results of each sample analysis is included in Table A-1 of Appendix A. Although the 8-hour, OSHA PEL was not exceeded for any of the above chemical contaminants (where applicable), significant concentrations of some were detected. Table I reports the range of concentrations found, and applicable recommended standards for each compound. All values are representative of 8-hour, TWA exposures.

These data indicate the potential for exposure to a wide range of chemical compounds during any given day. Although none of the results individually exceeded recommended guidelines, very little is known regarding the combined effect of all of these compounds on the body. Accordingly, efforts should be applied to minimizing all exposures through the use of proper protective equipment (gloves, goggles, aprons, etc.) and adequate ventilation. These items are addressed in section 4.4 of in this report.

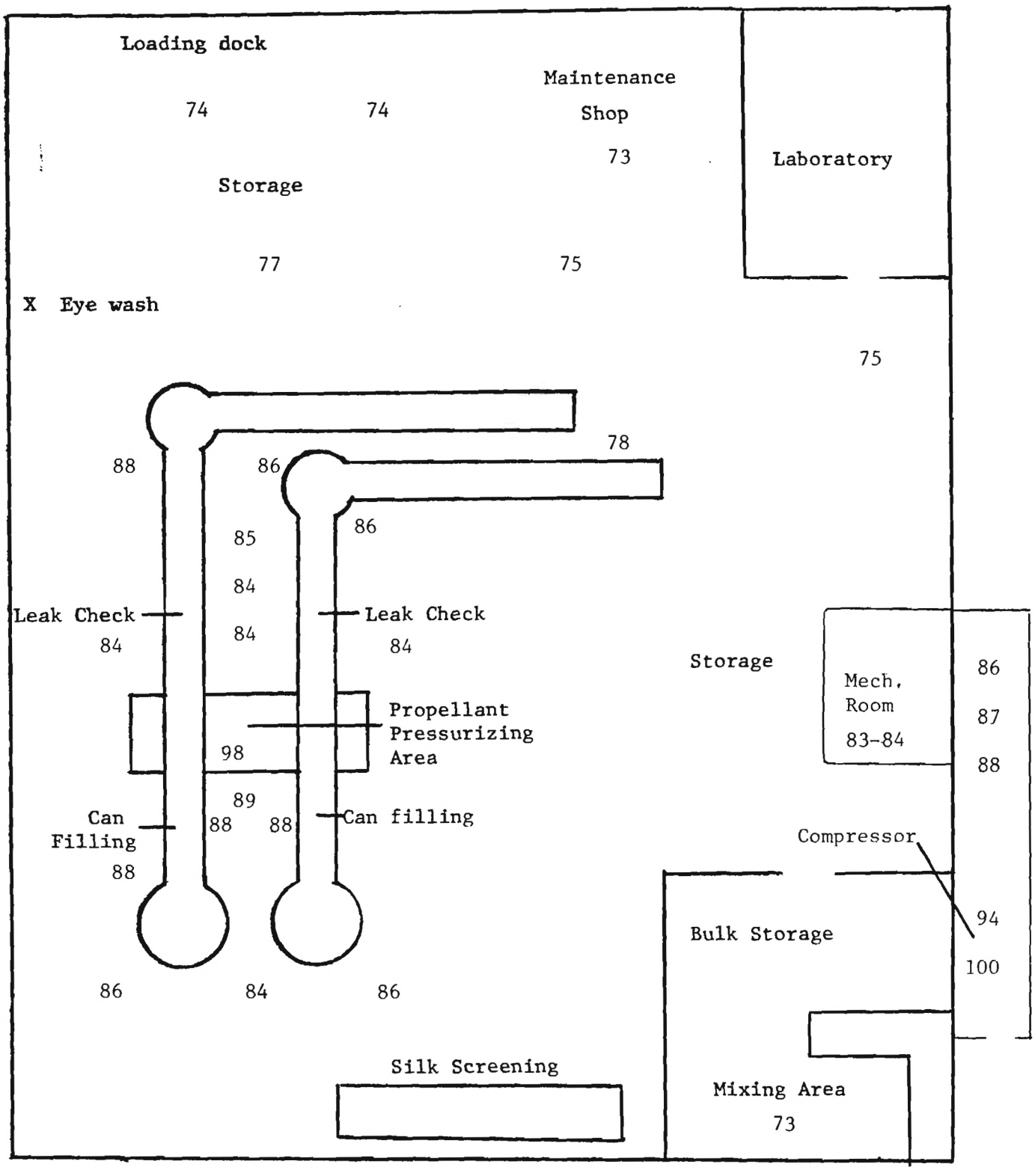
It should be noted that methylene chloride has recently been found to cause cancer in laboratory animals, according to the National Toxicology Program (Chemical & Engineering News, October 4, 1982, p. 13). The recommended limits in Table I were promulgated before this information was available. At the present time, further information regarding recommended actions has not been released by NIOSH or OSHA. Accordingly, every effort should be made to minimize employee exposure to methylene chloride until further information is available.

The data indicate that the employees receiving the greatest exposure are those filling cans with the product. It was noted that there is no local exhaust ventilation to remove the organic vapors from the workplace at the source. On the first day of sampling (8/17/82), Choke and Carb Cleaner was being run on the east line and PLS and Zepreserve were the products on the west line. On the second day of sampling (9/30/82), Brake

TABLE I

Range of Concentrations Found For Selected Chemical Contaminants

Contaminant	Range (parts per million)	OSHA PEL	NIOSH RPEL	ACGIH TLV
n-hexane	0.11 - 0.34	500	100	100
Hexane equivalent	0.42 - 1.00	-	-	-
1,2-epoxy butane	0.07 - 0.23	-	-	-
1,1,1-trichloroethane	2.34 - 52.	350	350	350
Methylene chloride	1.70 - 12.5	500	75	100
Perchloroethylene	0.27 - 6.4	100	50	100
Toluene	0.09 - 2.14	200	100	100
Xylene	0.59 - 2.24	100	100	100
Ethyl benzene	0.06 - 0.21	100	-	100
p-ethyl toluene	0.06 - 0.16	-	-	-
Trimethylbenzene	0.07 - 0.20	-	-	25
C_8-C_{10} aromatics	0.16 - 0.42	-	-	-
Butyl cellosolve	0.10	50	-	25
o-dichlorobenzene	0.004 - 0.048	50	-	50
p-dichlorobenzene	0.004 - 0.026	75	-	75



A-Weighted Sound Level Measurements (dBA)
Zep Manufacturing Company
Aerosol House

Figure 4.0-1

Parts Cleaner was run on the east line and the west line was not in use. As expected, there was a direct correlation between the constituents of the product handled and the compounds measured in the air.

The industrial hygienist was informed at the time of the survey that plans are to move the aerosol packaging operation to another building. When this is done, local exhaust ventilation should be supplied at the filling stations to reduce the amount of volatile organic vapors into the air.

4.2 CARBON MONOXIDE

Personal and area sampling was conducted to measure employee exposure to carbon monoxide. The source of carbon monoxide was a propane-fired lift-truck operating in the area. The results of personal samples indicated values below the current OSHA 8-hour TWA PEL of 50 ppm. It was noted that during the sampling period the doors to the aerosol house were open. This aided the general ventilation and probably diluted the exhaust gases.

Area sampling conducted at the east and west filling lines measured a range of carbon monoxide concentrations from approximately 5-50 ppm with the average around 22-25 ppm. Should the propane-fired lift-truck be used at the new location, carbon monoxide measurements should be made to assure employees are protected from exposure to high concentrations of carbon monoxide.

4.3 NOISE

Area noise measurements were conducted throughout the aerosol to determine A-weighted sound levels. These measurements are recorded on the sketch of the aerosol at the points where they were taken (see Figure 4.0-1). It should be noted that both lines were in operation when these measurements were made.

The highest noise was located at the compressor north of the mixing area. Although A-weighted continuous noise in this area is well above the OSHA 8-hour limit of 90 dBA it does not present a hazard since no employees work in this area. According to the aerosol house supervisor, maintenance employees may enter this area on occasion to perform maintenance activities, but ony when the compressor is off.

The areas of concern are the can filling and leak checking areas. The results of noise dosimeter measurements indicated three employees in these areas exposed to noise above the "action level" set by OSHA. This "action level" is 85 dBA continuous noise for 8 hours. The OSHA PEL is 90 dBA continuous noise for 8 hours. The results revealed that employees working at can filling and leak check did not exceed the 90 dBA PEL, but did exceed the 85 dBA "action level". The following several paragraphs will clarify this somewhat confusing OSHA standard.

The new amendment to the OSHA Noise standard actually requires that two noise level exposures be determined. One is an "action level" of 85 dBA and the other is a 90 dBA permissible exposure level. Both of these levels are time-weighted averages over an eight-hour work shift.

However, the ranges of noise levels used to make the two determinations are different. For the "action leel" of 85 dBA, all noise impulses between 80 and 130 dBA are included in the calculation. For the 90 dBA permissible exposure level, only those noise impulses between 90 adn 130 dBA are included in the calculation. Consequently, the employee exposure results determined by the "action level" measurement criteria should be a higher value than the employee exposure results determined by the 90 dBA permissible exposure level criteria. This is because of the fact that any readings between 80 and 89 are included in the "action level" calculation but the readings would simply represent zero noise levels when calculating the 90 dBA permissible exposure level and would therefore lower the average value.

Major hearing loss studies show 85 dBa as the level where the risk of hearing impairment becomes fairly significant. While exposures to 80 dBA indicate a 0 to 5% risk, exposures at 85 dBA indicate a 10 to 15% risk of hearing impairment. At 90 dBA, this risk jumps to 21 to 29%.

To summarize, employees exposed in excess of the action level should be enrolled in an effective hearing conservation program. A summary of the program requirements are included in Appendix C of this report. It should be noted that hearing protection (earplugs, muffs, etc.) are not required by OSHA at this point but must be made available to the employees should they choose to wear them. Many companies, however, have adopted a policy of mandatory wearing of protective devices at 85 dBA.

Three major noise sources were identified. These include noise emitting from the propellant pressurizing room, noise from the air nozzles subsequent to the leak check areas used to eject water from tops of aerosol cans, and from the many can-to-can impacts. Engineering controls to reduce noise should be implemented when the aerosol operations are moved into another building. These and additional recommendations are included in section 2.0 of this report.

4.4 MISCELLANEOUS

Several employees were chosen at random and questioned regarding various chemicals they were handling or may use periodically. With the exception of the compounder, the employees did not know the compounds used or what hazards were associated with each compound. All were aware of potential eye hazards and wore safety glasses with side shields except the compounder. The only protective equipment the compounder was observed wearing on the two days was a pair of leather gloves. It was noted that goggles and aprons are available for use and a sign in the area states that goggles are required in the compounding area. Leather gloves are not appropriate since they absorb the materials allowing skin absorption. Recommendations concerning personal protective equipment is included in section 2.0 of this report.

Aisles should be kept free of obstructions to be used in the event of fire. The eye wash located along the south wall should be repaired. In its present condition it sprays water onto the charger for the electric lift-truck creating a serious electrical hazard for employees in the area. The charging station and the eye wash should be separated.

One bulk sample of deteriorating tank lagging (insulation) was collected and analyzed for the presence of asbestos. The insulation was from the tank located in the aerosol house compressor. The sample was found to contain approximately 5% fiberglass and 5% mineral wool in particulate. No asbestos was detected in the sample.

Observations of the chemical storage area behind the aerosol house indicated several deficiencies. Currently, solvents and other chemicals (flammable and non-flammable) are stored in 55-gallon drums stacked at five locations. At all five locations there is a significant risk that the drums can be hit by trucks passing through the area or backing up to loading docks. As a minimum, steel posts should separate the storage areas from access roads and parking areas.

There are numerous types of compounds stored in this area, many of which are flammable or highly toxic. Many of the drums do not have labels. Other labeled drums do not list the generic name(s) of the compounds. Each of the materials should be classified according to the National Fire Protection Association (NFPA) scheme and the storage guidelines followed. It appears that recommended storage guidelines for several flammable materials, such as morpholines are not being followed.

Currently, run-off from the chemical storage area proceeds down an embankment east of the aerosol house into a drainage ditch adjacent the railroad. Additional run-off proceeds west from the area along the driveway and into the city storm sewers. At the present time there are no procedures to contain a spill should any drum(s) be ruptured. All chemical storage areas should be graded in such a manner that run-off will proceed to one location. This one location can then be provided a gate to contain any hazardous materials spill.

Although housekeeping practices need to be improved (especially in the mixing area), this problem should be remedied upon moving to the new location where more space will alleviate overcrowding.

This report prepared by: William M. Ewing

William M. Ewing
Industrial Hygienist

This report approved by: James L. Burson

James L. Burson, CIH, CSP
Chief, Safety and Health Divison

APPENDIX A

Results of Sampling

Plant ZEP MANUFACTURING COMPANY

Atlanta, Georgia (Aerosol Plant)

Materials n-Hexane (n-H), Hexane equivalent (HE), 1,2-epoxy butane (1,2-EB), 1,1,1-trichloroethane (1,1,1-T), Methylene Chloride (MeCl), Perchloroethylene (Per), Toluene, Xylene, Ethyl benzene (E Bz), p-ethyl toluene (p-ET), Trimethylbenzene (TMB), C8-C10 Aromatic Hydrocarbons (C8-C10), Butyl Cellosolve (Butyl C) o-Dichlorobenzene (o-Dcb), p-Dichlorobenzene (p-Dcb)

Date 1982	Sample Number	Description	Sampling Period		Concentrations								Concentrations						
			Start	Stop	n-H (ppm)	HE (ppm)	1,2-EB (ppm)	111-T (ppm)	MeCl (ppm)	Per (ppm)	Toluene (ppm)	Xylene (ppm)	E Bz (ppm)	p-ET (ppm)	TMB (ppm)	C8-C10 (ppm)	Butyl C (ppm)	o-Dcb (ppm)	p-Dcb (ppm)
8/17	CT-26	V. Dozier, filling cans, east line, Choke & Carb Cleaner	0759	1426	0.32	1.00	0.13	4.79	8.01	0.65	0.29	2.05	0.21	0.11	0.16	0.42	0.10	0.004	0.026
8/17	CT-27	L. Jackson, filling cans, west line, PLS & Zepreserve	0805	1424	0.34	0.89	0.23	12.4	12.5	0.92	0.09	1.33	0.16	0.16	0.20	0.42	---	0.048	0.004
8/17	CT-28	M. Davenport, Compounder	0815	1433	0.11	0.42	0.07	2.34	1.70	0.27	0.09	0.59	0.06	0.06	0.07	0.16	---	---	---
8/17	CT-29	L. Wright, Checking leaks and filling cans with Choke & Carb	0825	1425	0.11	0.81	0.11	4.06	10.4	0.55	2.14	2.24	0.18	0.10	0.13	0.40	---	0.005	0.023
		OSHA Permissable Exposure Limit			500	--	--	350	500	100	200	100	100	--	--	--	50	50	75
		NIOSH Recommended PEL			100	--	--	350	75	50	100	100	--	--	--	--	--	--	--
		ACGIH Threshold Limit Value			100	--	--	350	100	100	100	100	100	--	25	--	25	50	75

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

Report No. N/A

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing
Aerosol House

Materials 1,1,1-Trichloroethane (TCE)
Perchloroethylene (Perc)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			TCE (ppm*)	Perc (ppm*)
9/30/82	CT-10	P. Puckect, Filling cans east line	0923	1040	8.01	77	52.	6.4
9/30/82	CT-11	R. O'Shields, Filling cans east line	0926	1040	7.99	74	8.1	1.9
9/30/82	CT-12	L. Goodrum, Checking leaks east line	0929	1040	7.46	71	6.0	2.5

*parts per million

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

Report No. N/A

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Zep Manufacturing Co.
Aerosol House

Materials Carbon Monoxide (CO)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			CO (ppm*)	
8/17/82	CO-1	J. Brown, lift operator	0835	1433	7.2	358	14.	
8/17/82	CO-2	D. Walter, labeling (sw corner)	0843	1422	6.8	339	6.	

*part per million

TABLE A-4

Results of Bulk Sample Analysis
for
McLain & Merritt, P.C.

Sample Identification	Analytical Results
S-1, laboratory ID No. 1481, Tank lagging from aerosol house compressor room	No forms of asbestos were detected. The sample was found to contain approximately 5% fiberglass and 5% mineral wool in particulate matter

Sample was analyzed by polarized light microscopy (PLM).

Table A-5

Georgia Institute of Technology
Engineering Experiment Station

Report No. N/A

NOISE EXPOSURE DATA SHEET

Company Zep Manufacturing Co. (Aerosol House) Date 8/17/82 Test by W. Ewing

Dosimeter Model No. DuPont

Operating Conditions Normal Calibrator Model No. C-114 S/N 163084

	Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Start/Stop	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
	9693	4284	M. F. Adfor, ½ day filling cans and ½ day checking leaks	0808 / 1426	378	89	--
	9696	4804	H. Robinson, fillings cans, on the west line	0812 / 1423	371	92	--
	9700	4513	R. Applings, line mechanic, throughout area	0822 / 1424	362	87	--
*	8120	4857	P. Puckect capping cans on line	0828 / 1430	362	--	86
*	8108	4860	J. Brown lift operator	0835 / 1433	358	--	<70

*dosimeters set with 90 dBA cut-off, all others set with 80 dBA cut-off

APPENDIX B

Sampling and Analytical Methods

CARBON MONOXIDE

Sampling for carbon monoxide (CO) was conducted by using the following two techniques.

Short-term area sampling (direct reading instantaneous) was performed either by drawing measured volumes of air through a length of stain detector tube via a hand-operated sampling pump, or by a direct-reading meter.

In the detector tube system, the CO indication is based upon the reduction of potassium palladosulfite impregnated silica gel giving a color change of yellow to brown in the presence of CO. The length of stain of the detector chemical is proportional to the CO concentration (in ppm) and must be matched to a chart corresponding to the number of pump strokes employed (1 full stroke = 100 cc) on the instruction sheet which accompanies the tubes.

The basic principle of operation of the direct reading meter involves drawing air (pre-cleansed to remove interferences) through an electrochemical sensor cell at a nominal flowrate of 700 cc/minute. The sensor cell is composed of a catalytically active sensing electrode (platinum), a counter electrode, a reference electrode and an aqueous sulfuric acid solution as the electrolyte. In the direct reading meter, the electrochemical process is carried out at a potential-controlled electrode. The current measured upon introduction of CO to the sensor cell is the result of the electro-oxidation of CO to carbon dioxide (CO_2) and is proportional to the partial pressure of CO in the sampled air.

NOISE

Sound pressure level measurements were taken with Type II Sound Level Meters manufactured in accordance with the American National Standards Institute (ANSI) S1.4 - 1971 "Specifications for Sound Level Meters". General area and operator station sound pressure levels were measure on the "A-weighted slow response" integrating network, which approximates the response of the normal human ear to sound, at the workers' ear level as specified in ANSI S1.13 - 1971 "Methods for the Measurement of Sound Pressure Levels".

When industrial noise is transient and variable, a reasonably accurate determination of compliance with existing standards can be made with an Audio Dosimeter which automatically time-weights and integrates the various exposure conditions. Readings from this devise are reported as a percentage of the current allowable exposure limit and have been corrected to reflect eight-hour, time-weighted averages. A representative number of sound level readings are taken while the dosimeters are being used in order to verify the dosimetry percentage readings.

The first step in the engineering control of industrial noise requires a comprehensive characterization of all major sources of noise, including an analysis of the individual sound pressure levels in the 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16000 using approved Octave Band Analyzers.

All noise instruments were calibrated in accordance with the manufacturers' recommendations prior to and immediately following use. Sound level meters were calibrated using the appropriate Sound Level Calibrators.

NOISE DOSIMETRY

Noise dosimetry studies of employee noise exposures were made using DuPont, Model D-376, Audio Dosimeters, set for a 90 dBA cutoff.

Sound levels reaching the employee were detected by a non-directional ceramic microphone worn on the shirt collar. This input is attenuated using the "A" weighting scale described in the American National Standards Institute S1.4-1971 "Type 2 Specification". If the microphone picks up any continuous sound over 115 dBA, it is recorded and stored for later inspection.

Next, noise below the cutoff level, 90 dBA, is removed on a continuous basis. The ratios of actual exposure to established limits at every sound level between 90 and 115 dBA are calculated and integrated with time to give the actual exposure during the workday as a percentage of that permitted by the regulations.

Data storage is accomplished by means of an electroplating reaction that occurs within an integrating memory cell. The information is stored in the cell until it is retrieved in a DuPont, Model R-225 readout instrument by reversing the electroplating reaction. The memory cell is automatically cleaned for reuse as the exposure information is retrieved.

Prior to use, the Audio Dosimeter battery is checked with an internal battery check and calibrated at two sound levels with a DuPont, Model C-114, calibrator.

ORGANIC VAPORS

Samples were collected by using battery-powered, portable pumps to draw air at measured flowrates through:

1. Charcoal Sample Collection Tubes, containing 450-milligram (front) and 150-milligram (back) sections of activated charcoal, or

2. Charcoal Tubes containing 100-milligrams (front) and 50-milligram (back) sections of activated charcoal.

Immediately after sampling, the ends of tubes were sealed with polyethylene caps for transport to the laboratory, where they were refrigerated until analysis.

In the laboratory, front and back sections of each tube were desorbed separately in appropriate volumes of carbon disulfide, and aliquots of the resultant solutions injected into a gas chromatograph. Quantites of each analyte present were determined by comparison of areas under the sample chromatogram peaks with areas under chromatogram peaks for standards prepared in carbon disulfide. Analytical results, which include any necessary corrections for parallel blank and recovery determinations, were used in conjunction with sampling data (volume of air sampled) to calculate the concentrations of airborne analytes represented by each sample, expressed in parts analyte per million parts of air, by volume (ppm).

APPENDIX C

Toxicological Information

BUTYL CELLOSOLVE

Butyl cellosolve ($C_4H_9OCH_2CH_2OH$), ethylene glycol monobutyl ether, 2-butoxyethanol) is a colorless liquid with a slightly rancid odor.

It can be absorbed via inhalation of vapor and percutaneous absorption of liquid. It penetrates the skin readily and toxic action from excessive skin exposure may in some instances, be more likely than from vapor inhalation. However, in most industrial settings, vapor inhalation is the most significant route of exposure.

Acute exposure to butyl cellosolve results in narcosis, pulmonary edema, and severe kidney and liver damage. Symptoms from repeated overexposure to vapors are fatigue and lethargy, headache, nausea, anorexia, and tremor. Rats show increased hemolysis of erythrocytes from inhalation of butyl cellosolve.

Butyl cellosolve is irritating to the skin and mucous membrances. Vapor exposure may cause conjunctivitis and upper respiratory tract irritation. Temporary corneal clouding may also result and may last several hours. Exposures to 100 ppm result in eye, nose, and throat irritation in some persons. Acute intoxication in animals causes death, if early, due to narcosis, and if delayed for several days, to pneumonitis and kidney injury.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 50 ppm as a standard for occupational exposure. ACGIH currently lists as "tentative" a short-term exposure limit (up to 15 minutes) of 150 ppm. This value carries the "skin" notation, warning of the potential for percutaneous absorption; this specific concentration limit is based on the presumption that there is no concurrent exposure via the skin absorption and oral ingestion routes.

CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless gas generally produced by incomplete combustion of organic or carbonaceous materials. It is a serious hazard in many processes in the chemical, iron and steel, pottery, automobile, and mining industries.

Of all the gases that have poisonous effects upon man and animals, carbon monoxide is the most widely encountered. It exerts its effects by combining with the hemoglobin of the blood and interrupting the normal oxygen supply to the body tissues. Although this resultant oxygen deficiency is a reversible chemical asphyxia, nevertheless, damage done by severe asphyxia from any cause may not be reversible.

The acute effects of carbon monoxide exposures are dependent on the percentage saturation of hemoglobin with carbon monoxide, which in turn is dependent on the duration of exposure, concentration of carbon monoxide, the ambient temperature, and the health status and metabolic efficiency of the worker. The approximate relationship is shown in the following table.

Atmospheric Carbon monoxide concentration (ppm)	Half-time for accumulation (min)	Carboxy-hemoglobin concentration at equilibrium %	Principal Symptoms
50	150	7	Slight headache
100	120	12	Moderate headache and dizziness
250	120	25	Severe headache and dizziness
500	90	45	Nausea, vomiting collapse possible
1,000	60	60	Coma
10,000	5	95	Death

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established a permissible exposure limit (PEL) for an eight-hour, time-weighted average, (TWA) exposure of 50 ppm to maintain carboxyhemoglobin levels below 10%. The National Institute for Occupational Safety and Health recommends a time-weighted average exposure of 35 ppm for an eight-hour workday, with a ceiling concentration of 200 ppm. ACGIH currently lists as "tentative value" a short-term exposure limit (up to 15 minutes) of 400 ppm.

METHYLENE CHLORIDE

Methylene chloride (dichloromethane, CH_2Cl_2) is a colorless liquid with a sickly, sweet odor detectable at concentrations above 225 ppm. This odor cannot be considered a good warning because humans readily adapt to it.

In strong untraviolet light, or in contact with open flames or hot surfaces, or both, methylene chloride, in the presence of air and moisture, is decomposed with the formation of hydrogen chloride, carbon dioxide, carbon monoxide, and possibly the toxic gas phosgene. Therefore, welding which produces UV light should not be done near areas in which methylene chloride vapor may be present.

The toxicities of carbon monoxide and methylene chloride are similar. Methylene chloride is metabolized to carbon monoxide in the body. Therefore, the carboxyhemoglobin concentration in blood is a function of the methylene chloride absorbed either through the skin or the lungs. Like carbon monoxide, the most important biological effects of methylene chloride are the significant interference with delivery of oxygen to tissues and abnormalities in the central nervous system's function. Complaints commonly reported by workers using this material include chest pains, heart palpitations, rapid pulse, shortness of breath, dyspnea, tingling in the hands and feet, muscular pains in the arms and legs, headache, and increased fatigue.

Methylene chloride is mildly irritating to the skin on repeated contact. Liquid methylene chloride splashed in the eyes will be painful and irritating, but it is not likely to cause serious injury. Methylene chloride can be absorbed through the skin.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends an eight-hour, time-weighted average (TWA) threshold limit value of 100 ppm in air with a short-term exposure limit of 500 ppm for a period up to 15 minutes. The Occupational Safety and Health Administration (OSHA) has adopted the American National Standards Institute (ANSI) standard (Z37.3-1969) which established an eight-hour, TWA concentration limit of 500 ppm, along with an acceptable ceiling concentration of 1,000 ppm, not to be exceeded for longer than five minutes in any two hours, and a maximum peak concentration of 2,000 ppm, not to be exceeded at any time. The National Institute for Occupational Safety and Health (NIOSH) has recommended a standard of 75 ppm as a TWA for up to a 10-hour workday, in the absence of occupational exposure to carbon monoxide. In the presence of exposure to carbon monoxide in excess of 9 ppm TWA, the combined concentrations of carbon monoxide and methylene chloride must be considered. NIOSH has recommended a ceiling concentration of 500 ppm as determined by a 15 minute sampling period. The current OSHA PEL is 500 ppm for an eight-hour, time-weighted average exposure.

NOISE

The major potential health hazard associated with exposure to noise lies in the possibility of producing permanent hearing loss. Factors which play a role in deciding how much permanent hearing loss will be sustained after exposure to high noise levels include the level and frequency of the noise, the duration of exposure per day, the number of years of repeated daily exposure, and individual susceptibility (age, genetic make-up, diet, and use of autotoxic drugs are just some of the variables which determine individual susceptibility).

The other adverse effects suspected as being caused by high noise levels include physiological disturbances (high blood pressure, aural pain, nausea and impaired muscular control when exposure is severe), and an increase in the accident frequency rate resulting from interference with speech communication and the disrupting of concentration. Also, some temporary hearing loss results from daily exposure to high noise levels, reportedly because the hair cells in the inner ear become fatigued and can no longer respond as well.

The standard as set by the Occupational Safety and Health Administration (OSHA) is based on daily time-weighted average exposure limits (over an eight-hour period) which, it is thought, will protect most workers from serious hearing loss.

The elements of the OSHA standard are:

1. The acceptable level of continuous noise (amplitude peaks less than one second apart) for exposures of eight hours duration is 90 decibels (dB) as measured on the A-weighted integrating network of a Type II sound level meter set on slow response, which approximates the response of the normal human ear to sound.

2. For each additional 5 dBA above 90, the permissible exposure time is reduced by half (see Table 1 below).

TABLE 1

PERMISSIBLE NOISE EXPOSURES

Sound Level (dBA)	Hours/Day Duration
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼ or less

3. No exposure to continuous noise levels in excess of 115 dBA is acceptable, regardless of duration.

4. Exposure to impulsive or impact noise (amplitude peaks greater than one second apart) in excess of 140 dB peak sound pressure level is unacceptable.

5. When workers are being overexposed on the basis of the criteria in Table 1, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

6. In all cases where the noise levels exceed an equivalent noise level of 85 dBA, including noise levels from 80 to 130 dBA, a continuing effective hearing conservation program shall be administered. The allowable duration of exposure is determined by the formula:

$$\text{Allowable time (Hours)} = \frac{32}{2^{(L-80)/5}}$$

where L is the sound level measured on the A weighted scale (dBA).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, as it is in most jobs in industrial settings, the combined effect shall be considered, rather than the individual effect of each. This combined effect, or total exposure, is determined by the following exposure formula.

$$\text{Exposure} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

Where C_n is the actual time spent at sound level, n (in dBA), and T_n is the allowable time spent at sound level, n.

OSHA has defined an effective hearing conservation program, but parts of the definition have been stayed. The portions which have not been stayed are summarized below:

1. Baseline audiometric testing must be completed by August 22, 1982, and repeated annually thereafter. All audiograms must be kept for the duration of employment.

2. Audiometric tests must be given by a trained individual and the audiometer must meet the ANSI S3.6-1969 criteria. Audiometer calibrations must be done as stated in the OSHA standard.

3. Audiograms showing a significant threshold shift must be reviewed by an audiologist, otolaryngologist, or qualified physician.

4. Employees must be notified of audiogram results within 21 days of receipt of the results. Hearing protection must be worn by employees having a significant threshold shift when working in areas where noise levels exceed 85 dBA.

5. Employees exposed to an equivalent noise level of 85 dBA or greater must have annual training which includes discussions of the effects of noise on man, the use of hearing protection, and audiometric testing.

6. When employees are exposed to greater than 90 dBA a written plan to reduce noise exposures to less than an equivalent noise level of 90 dBA must be formed. The plan may include both engineering and administrative controls.

PERCHLOROETHYLENE

Perchloroethylene (1,1,2,2-tetrachloroethylene) is a colorless solvent with an odor like ether or chloroform. Human exposure to high concentrations of the vapor in air may result in maladies of the liver, kidneys, eyes, upper respiratory system, and the central nervous system. Skin contact with liquid perchloroethylene may result in skin burns, blistering, erythema. Skin effects due to chronic perchloroethylene exposure (in air) may result in eczema.

Symptoms of exposure to perchloroethylene vapors vary depending on the concentration. At relatively low concentrations (75-100 ppm) one may experience lightheadedness, slight eye irritation, throat irritation, and frontal headache. At higher concentrations symptoms of fatigue, vertigo, nausea, and vomiting may become apparent. Prolonged exposure to high concentrations may lead to liver dysfunction, pulmonary edema, kidney failure, neurological disorders, coma, and eventually death.

The current Occupational Safety and Health Administration Permissible Exposure Limit for perchloroethylene is 100 ppm based on a 8-hour, time-weighted average (TWA). The National Institute for Occupational Safety and Health's recommended standard is 50 ppm based on a 10-hour, TWA.

TOLUENE

Toluene (toluol, methyl benzene) is a clear, colorless, non-corrosive liquid with a sweet, pungent odor. Toluene is readily absorbed from the lungs, the gastrointestinal tract, and to a small extent, through the intact skin. Part of the absorbed toluene is eliminated in the expired air, but a large percentage is excreted in the urine. The only industrial hazards of significance result from inhalation of excessive concentrations of vapor, prolonged skin contact with the liquid, and liquid contamination of the eyes.

With acute exposure, toluene acts predominantly upon the central nervous system as a depressant causing fatigue, headache, confusion, paresthesia, dizziness, and muscular incoordination. There is usually some delay in the development of symptoms, and hence the effects commonly appear at the end of the work shift. With sustained exposure to high concentrations, death may ensue from paralysis of the respiratory centers.

Continuous daily exposures to low concentrations of toluene vapors may give rise to a clinical picture of chronic intoxication. Such cases may show varying degrees of fatigue, general nervousness, insomnia, and loss of appetite and weight. Frequent and sustained skin contact with liquid toluene may result in the development of dermatitis because of the defatting properties of toluene as well as its local irritative action. Toluene does not cause the severe injury to the bone marrow characteristic of benzene.

The Occupational Safety and Health Administration has adopted the ANSI Z37.12-1967 Standard for Exposure to toluene, which established an eight-hour, time-weighted average of 200 ppm with a ceiling of 300 ppm and an acceptable peak exposure of 500 ppm for a duration of not more than ten minutes if encountered not more than once during an eight-hour workday. The American Conference of Governmental Industrial Hygienists has established a threshold limit value of 100 ppm as an eight-hour, time-weighted average. The National Institute for Occupational Safety and Health recommends an eight-hour, time-weighted average of 100 ppm with a ceiling of 200 ppm as determined by a sampling time of ten minutes. The American National Standards Institute, Inc. revised the ANSI Z37.12-1967 in 1974. It has established a new acceptable eight-hour, time-weighted average maximum for peaks above the acceptable ceiling concentration of 500 ppm for a duration of not more than 10 minutes if encountered not more than once a day.

TOTAL HYDROCARBONS

Hydrocarbons are compounds whose molecules consist of atoms of hydrogen and carbon only. The hydrocarbons of concern in this document are those emitted into the atmosphere as contaminants by motor vehicles. Hydrocarbons having between one and four carbon atoms are gaseous at ordinary temperatures, whereas those with more than five carbon atoms are liquids or solids in the pure state. Hydrocarbons generally fall into three classes: straight chain, cyclic and aromatic. These can enter the human body via inhalation of the gases or vapors.

The main toxic action of straight chain and cyclic hydrocarbons is depression of the central nervous system with symptoms of giddiness, dizziness, hilarity and headache. Severe exposure may result in loss of consciousness associated with convulsive effects which are sometimes fatal. Moderate to severe absorption may produce various types of pulmonary inflammation. Certain aromatic hydrocarbons are more irritating to mucous membranes than equivalent concentrations of the straight chain and cyclic hydrocarbons, and systemic injury can result from their inhalation. Hematological (blood) abnormalities have also been associated with the aromatic hydrocarbons. The chronic effects of inhaling benzene, an aromatic hydrocarbon, over a prolonged period of time are important because benzene is considered to be a carcinogen acting on blood-forming tissues.

The Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted average (TWA) concentration limit of 500 ppm (2,000 mg/m^3) for petroleum distillates. The National Institute for Occupational Safety and Health (NIOSH) recommends a TWA concentration limit of 350 mg/m^3 and a 15-minute ceiling concentration limit of 1,800 mg/m^3 for petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits and Stoddard solvent.

1,1,1-TRICHLOROETHANE

1,1,1-trichloroethane (methyl chloroform, CH_3CCl_3) is a colorless, nonflammable liquid with an odor similar to chloroform. Upon contact with hot metal or exposure to ultraviolet radiation, it will decompose to form the irritant gases hydrochloric acid, phosgene, and dischloroacetylene.

It acts as a narcotic and depresses the central nervous system. Acute exposure symptoms include dizziness, drowsiness, increased reaction time, unconsciousness, and death. Impairment of the central nervous system, to the extent that escape would be impossible, has occurred experimentally in human subjects when the exposure concentration of 1,1,1-trichloroethane was increased from zero to 2,650 ppm during 15 minutes. Impaired coordination and balance have also been demonstrated in experimental exposures of human subjects to 1,1,1-trichloroethane at 900-1,000 ppm for 20 minutes or more.

Liquid and vapor are irritating to eyes on contact. This effect is usually noted first in acute exposure cases. Mild conjunctivitis may develop but recovery is usually rapid. Repeated skin contact may produce a dry, scaly, and fissured dermatitis, due to the solvent's defatting properties.

Animals exposed repeatedly to high concentrations exhibited some reversible changes in liver, but they were not severe effects associated with carbon tetrachloride. Chronic exposure to 1,000 ppm resulted in moderate fatty degeneration of the liver but no liver necrosis or kidney injury.

1,1,1-trichloroethane has been shown to have a direct effect on the cardiovascular system. Depression of the circulatory system was found, evidenced by a drop in blood pressure.

To prevent odor, mild irritation and the possible effects of prolonged undue exposure, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 350 ppm as a standard for occupational exposures. ACGIH has also recommended a short-term exposure limit of 450 ppm (up to 15 minutes). The National Institute for Occupational Safety and Health (NIOSH) has recommended a ceiling concentration of 350 ppm as determined by a 15 minute sample.

XYLENE

Xylene (xylol, dimethyl benzene) is a clear colorless, flammable liquid having an aromatic odor similar to that of benzene and toluene. There are three isomers, ortho (1,2-dimethyl benzene), meta (1,3-dimethyl benzene), and para (1,4-dimethyl benzene). Commercial xylene is a mixture of the three forms with meta being the major component.

Inhalation is the primary exposure route for absorption of xylene. Although xylene can be absorbed through the skin, this is not a significant factor in industrial exposures.

Acute exposures to high concentrations result in a narcotic effect on the central nervous system which can lead to unconsciousness. Characteristic indications of acute exposure include giddiness, fatigue, palpitation, dyspnea, anxiety, and numbness of hands and feet.

Effects of chronic exposure to xylene are headache, fatigue, lassitude, irritability, and in some cases, digestive disturbances, but xylene does not produce the severe hematological changes characteristic of chronic benzene poisoning. Higher concentrations or longer exposure periods can cause eye and respiratory tract irritation, and the beginning of narcotic effects which may limit self-rescue ability. The defatting action on the skin can lead to severe dermatitis following repeated or prolonged contact.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average concentration limit of 100 ppm as a standard for occupational exposure. ACGIH currently lists as "tentative" short-term exposure limit (up to 15 minutes) of 150 ppm. The National Institute for Occupational Safety and Health (NIOSH) recommends a time-weighted average exposure of 100 ppm for up to a 10-hour workday, 40-hour workweek, with a ceiling concentration of 200 ppm as determined by a sampling period of 10 minutes.